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Non-Linear Modeling Parameters for Reinforced Concrete Columns Subjected to Seismic Loads

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Non-Linear Modeling Parameters for Reinforced Concrete Columns Subjected to Seismic Loads

by

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Thesis

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Dedicated to Appa, Amma, Sayee

relatives and friends

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Abstract

Non-Linear Modeling Parameters for Reinforced Concrete Columns Subjected to Seismic Loads

by

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The University of Texas at Austin, 2010

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The American Society of Civil Engineers (ASCE) Standard 41-06 Supplement No.1 (2007) assists engineers in modeling and evaluating the non-linear behavior of structures till collapse. Different levels of conservatism were used throughout the standard to produce modeling parameters for different structural elements, which leads to inconsistencies at the system level. Task to update current ASCE 41-06 provisions pertaining to RC structures is now handled by ACI (American Concrete Institute) committee 369 entitled "Seismic Repair and Rehabilitation". This study is a part of ACI 369 committee's effort.

Existing provisions for non-linear analysis are re-assessed in this study for both rectangular and circular reinforced concrete columns. A database of 490 column tests was compiled for this project. Median rather than conservative estimates of non-linear modeling parameters were produced to achieve "best" estimates of structural behavior. Proposed modeling parameters show improved fit with experimental data over existing parameters. Data necessary for selection of acceptance criteria are provided.

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1. INTRODUCTION

1.1 Research Motivation

Seismic assessment and rehabilitation of structures is fast evolving as an important domain in earthquake engineering and is primarily focused on the existing structures. Seismic assessment serves as a tool to expose seismic deficiencies in a structure and guides the planning of rehabilitation schemes if necessary. Seismic rehabilitations are implemented on existing buildings either before or after an earthquake. The extent of rehabilitation depends on the level of damage foreseen through an assessment or that a structure has actually undergone. Many earthquakes have resulted in catastrophic collapse of structures. Structures with non-ductile reinforced concrete elements remain critical during seismic loading events as the failure in these elements can be sudden and brittle (Figures 1.1 and 1.2).

Figure 1.1: Extensive damage of a column in Olive View hospital during the 1971 San Fernando earthquake due to poor detailing of transverse reinforcement. (*courtesy: World Housing Encyclopedia*)

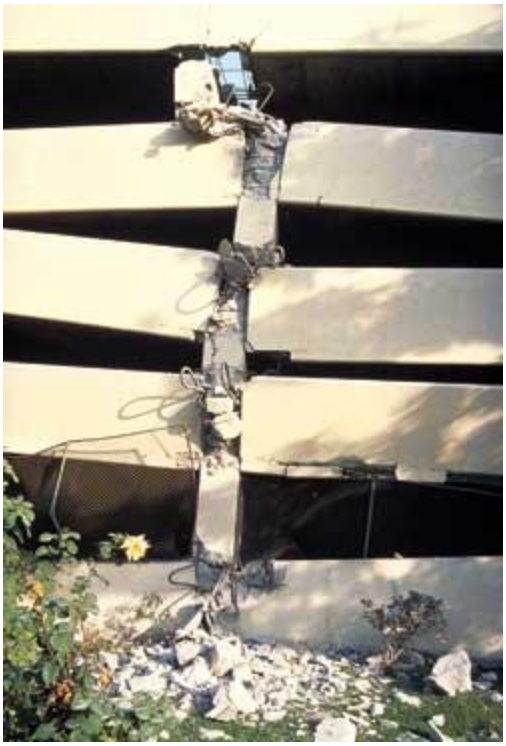


Figure 1.2: Collapse of parking structure in the 1994 Northridge earthquake (courtesy: Robert Reitherman)

Seismic rehabilitation can be both costly and time consuming. For any structure, seismic rehabilitation is the product of seismic assessment that identifies critical deficiencies. Improving the accuracy of seismic assessment can result in optimized rehabilitation schemes. Seismic assessment procedures that fail to accurately identify critical deficiencies in a structure can adversely affect the scope and magnitude of rehabilitation needs. For instance, a highly conservative assessment approach results in unnecessary rehabilitation measures thereby driving rehabilitation cost and time upwards. This study aims to improve the accuracy of existing assessment tools by bringing certain modifications to the reinforced concrete column provisions of ASCE 41-06 Supplement No.1.

To help assist practicing engineers, the ASCE 41-06 Supplement No.1 (2007) document entitled "Seismic Rehabilitation of Existing Structures" was developed. This document is the foremost reference in the United-States for structural assessment and rehabilitation. The main aim of this document is to serve as a reference for seismic assessment principles and procedures for various structural materials and elements. ASCE/SEI 41-06 reinforced concrete provisions were revised by a committee headed by Elwood et al. (2007) and the updated document was named ASCE 41-06 Supplement No.1 (2007). The updating of provisions pertaining to RC structures is now tasked to ACI (American Concrete Institute) Committee 369 entitled "Seismic Repair and Rehabilitation". This study is part of that effort.

1.2 Objectives and Scope

The primary objective of this study is to propose revisions to the non-linear procedures for reinforced concrete (RC) columns of ASCE 41-06 Supplement No. 1. Proposed revisions target modeling parameters that were developed for the non-linear analysis of RC columns. The study focuses on RC columns because of the large body of experimental data that is available and because of the importance of columns in collapse prevention. The scope of this study is limited to modeling parameters. Revisions to acceptance criteria are suggested as future work.

To achieve project goals, a database of 490 column tests was compiled. Linear regression combined with adjustments that consider component fragility curves were used to update modeling parameters for RC columns. Current modeling parameters were

derived using only rectangular column data. Circular columns are introduced in the database and new circular column modeling parameters produced.

1.3 Organization

Chapter 2 provides background information regarding the behavior of RC columns during earthquakes. It summarizes pertinent research and provisions of ASCE 41-06 Supplement No.1 (2007). ATC 58 (2009) recommendations for building fragility curves are presented.

Chapter 3 presents the details of the compiled database of columns that is used in this study. Pertinent parameters are discussed.

Chapter 4 details the work performed to revise RC column modeling parameters. This chapter serves as the crux of the study and involves developing linear regression models for plastic rotations, using ATC 58 (2009) fragility curve procedures, and estimating the new set of modeling parameters.

Chapter 5 presents the conclusions drawn from the study accompanied by suggestions for future work.

2. BACKGROUND

Reinforced concrete (RC) columns subjected to cyclic lateral loading that is typical during seismic events, exhibit three main failure modes: 1) flexure, 2) flexure-shear, and 3) shear.

2.1 Seismic Behavior of Flexure Critical RC Columns

Flexure Critical RC columns in this category (FC columns) generally perform well during an earthquake. Their mode of failure consists of longitudinal steel yielding or concrete crushing due to flexure and axial loads without any signs of shear failure. Such columns can sustain imposed lateral loads by undergoing large deformations without significant loss in lateral load capacity under relatively large lateral deformations (Figure 2.1). Loss of lateral load capacity for this mode can originate from cover spalling and longitudinal bar buckling. Axial collapse of such columns will usually occur due to longitudinal bar buckling, bar fracture, or lateral instability.

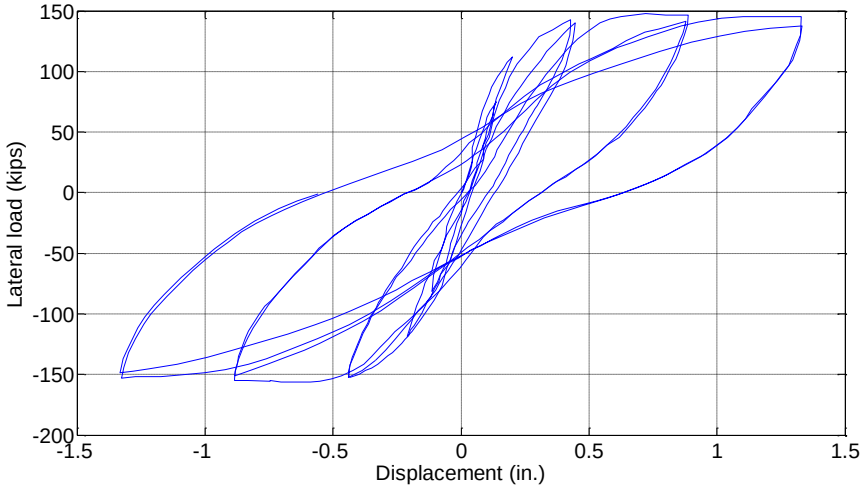


Figure 2.1: Force-displacement relation of a flexure critical column (No.1, Gill et al., 1979. *Column size:* 21.65*"* x 21.65*"*)

2.2 Seismic Behavior of Flexure-Shear Critical RC Columns

Flexure-shear critical RC (FSC) columns undergo flexural yielding or concrete crushing due to flexure and axial loads prior to sustaining shear failure; shear failure is defined as a reduction in lateral load capacity accompanied with significant inclined cracking. This can be observed as a yield plateau in a column force-displacement relation followed by a degrading slope ensuing form shear failure (Figure 2.2). In such columns, shear capacity is larger than the flexural capacity prior to yielding. As the plastic hinge regions sustain larger plastic rotations, shear capacity diminishes leading to shear failure. Axial collapse of such columns will occur when the shear damaged area can no longer carry imposed axial loads. Axial failure can occur at a significantly larger deformation demand than that creating shear failure.

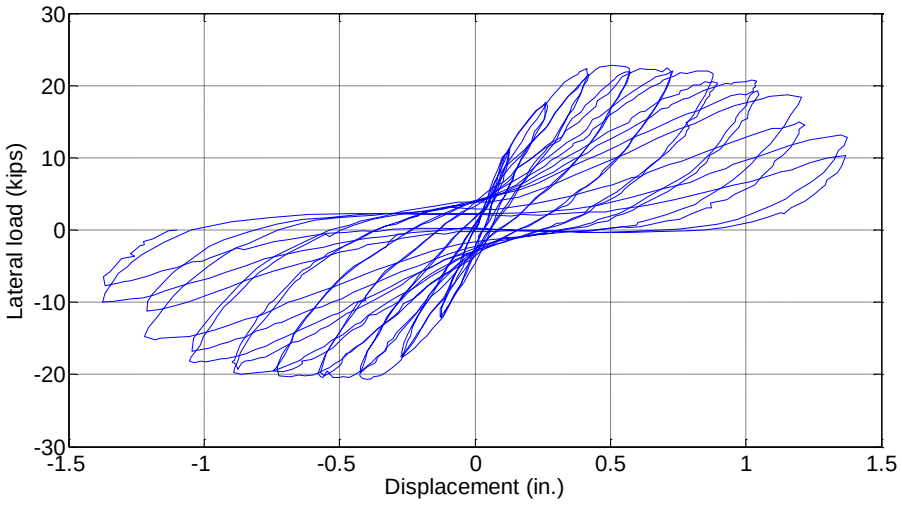


Figure 2.2: Force-displacement relation of a flexure-shear critical column (2D16RS, Ohue et al., 1985. *Column size:* 7.87*”* x 7.87*”*)

2.3 Seismic Behavior of Shear Critical RC Columns

Shear critical RC (SC) columns are characterized by failure in shear prior to or just after flexural yielding or concrete crushing due to flexure and axial loads. Shear failure in such columns under lateral seismic loads is usually marked by diagonal cracking that can extend through the mid height of the columns. Since there is no flexural yielding, this failure mode is brittle in nature. The force-displacement relationship of columns of this category is usually marked by degrading behavior (Figure 2.3). In Figure 2.4 shear failure in such columns is illustrated. Axial collapse of such columns will occur when the shear damaged area can no longer carry imposed axial loads. Axial failure usually occurs at relatively low deformation demands.

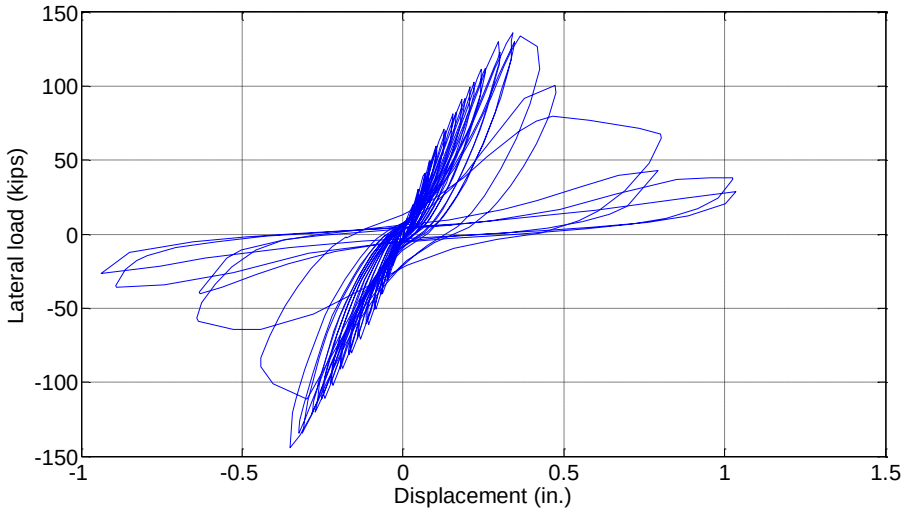


Figure 2.3: Force-displacement relation of a shear critical column (SC9, Aboutaha et al., 1999. Column size: 18″ x 36″)

Figure 2.4: A column in Olive View hospital damaged by shear failure during the 1971 San Fernando earthquake (*courtesy: World Housing Encyclopedia)* and shear failure of an experimental column (SC3, Aboutaha et al., 1999)

2.4 Strength-Based Shear Failure Models

Many models [e.g., Watanabe and Ichinose (1992), Aschheim and Moehle (1992), Priesltey et al. (1994), Kowalsky et al. (1997), Sezen (2004)] have been proposed to calculate the shear strength of reinforced concrete columns for design and assessment purposes. Shear strength based models are usually established in terms of shear contribution from concrete and transverse steel. While strength-based shear models perform well for shear critical columns, they do not perform well for flexure-shear critical columns where lateral strength is limited by flexural strength and shear failure is more a function of displacements rather than force. Recently, focus has significantly shifted from strength-based approaches to displacement-based approaches. Strength-based approaches fail to capture the inelastic response of structures which play a crucial

role in performance during seismic events; especially for flexure-shear and flexure critical columns.

2.5 Displacement Based Approaches

Several researchers have developed various displacement based models [e.g., Pujol et al. (1999), Kato and Ohnishi (2002), Elwood and Moehle (2005b), Ghannoum (2007), Mostafaei and Kabayesawa (2007)]. These models estimate deformation capacity of RC columns at shear failure. Such displacement based approaches help us evaluate the seismic behavior of columns beyond the elastic range (i.e., non-linear behavior). Flexure-shear critical and flexure critical columns undergo considerable amounts of inelastic lateral deformation before the occurrence of shear failure, if any. Given the relatively flat force-deformation relation of columns in the inelastic range, estimating deformations at shear failure becomes more accurate than estimating force at shear failure for FC and FSC columns. Hence consideration of inelastic response of columns becomes important and the various displacement based approaches address this need.

There are various parameters which influence deformation capacity of a column at shear failure. Main parameter considered in past research are axial load ratio$\left(\frac{P}{A_g f_c'}\right)$, transverse reinforcement ratio (ρ''), shear stress ratio$\left(\frac{V}{b\ d\ \sqrt{f_c'}}\right)$, tie spacing to depth ratio (*s/d*), as well as longitudinal compressive and tensile strains in core concrete.

where, P – applied axial load (positive in compression), A_g – gross area of column section, f_c' – 28-day compressive strength of concrete.

ρ'' is sectional transverse reinforcement ratio and can be calculated as

$$\frac{\text{area of transverse reinforcement in the direction of loading}}{(b\ d)}$$

V – shear strength of column, b – section width in the direction perpendicular to loading. For circular columns, b was taken as section diameter (as per section 11.2.3 of ACI 318-08).

d – effective depth of column section. For circular columns, d was taken as 0.8 times the section diameter (as per section 11.2.3 of ACI 318-08).

Increasing axial loads negatively impact deformation capacity of a column. Longitudinal bar buckling, concrete crushing are commonly observed in columns acted upon by high axial loads. These damages significantly limit the deformation capacity of a column at shear failure.

Transverse reinforcement provides confinement to longitudinal bars and helps deformation capacity of a column. Though generally transverse reinforcement has positive influence on the seismic performance of a column, maximum benefits can be achieved only through seismic detailing. Circular columns with spirals generally perform better compared to rectangular columns as spirals provide more and uniform confinement than rectangular non-seismically detailed ties. Spacing of transverse reinforcement also plays a vital in seismic performance of a column. For instance, a column with closely spaced ties would perform better than a column with similar loading conditions but with ties spaced farther apart.

Shear stress ratio negatively influences deformation capacity of a column. Higher shear stress demands typically imply less reserve shear capacity and that reserve is lost as inelastic deformations increase.

2.6 Existing ASCE 41-06 Supplement No.1 Provisions

ASCE 41-06 provisions are the leading provisions used for seismic assessment and rehabilitation of structures in the United-States. Assessment and modeling provisions are given for both linear and non-linear analyses. The focus here is on non-linear provisions that consider both force- and displacement limits for modeling and assessing RC columns subjected to seismic loads. Current provisions in Section 6.4.2.2.2 of ASCE 41-06 Supplement No.1 classifies columns into three conditions namely i, ii, and iii, based on the shear strength of columns prior to flexural yielding (V_o), plastic shear demand of columns corresponding to the plastic capacity of column flexural hinges (V_P), and detailing of transverse reinforcement (Table 2.1). Evaluation of V_P is described in detail in Chapter 3.

	Transverse Reinforcement Details		
	ACI conforming details with 135° hooks	Closed hoops with 90° hooks	Others (including lap spliced transverse reinforcement)
$V_P / V_o \leq 0.6$	i	ii	ii
$1.0 \geq V_P / V_o \geq 0.6$	ii	ii	iii
$V_P / V_o > 1.0$	iii	iii	iii

Note: *In addition to specified V_P / V_o , a column should have $\rho'' \geq 0.002$ and $s/d \leq 0.5$ within the flexural plastic hinge region to classified as i else the column shall be classified as ii.*

Table 2.1: Classification of columns into i, ii, iii based on ASCE 41-06 Supplement No.1

V_o is expressed in ASCE 41-06 Supplement No.1 as

$$Vo = \frac{A_v\ f_{yt}\ d}{s} + \left(\frac{6\sqrt{f_c'}}{M/Vd}\sqrt{1+\frac{P}{6\ A_g\sqrt{f_c'}}}\right)0.8\,A_g \quad \text{(psi units)} \qquad (2\text{-}1)$$

where f_{yt} – yield stress of transverse reinforcement, $\left(M/Vd\right)$ – is the ratio of applied moment to applied shear multiplied by effective depth; this measure is equivalent to the shear span to depth ratio for a column loaded only at the ends.

The three conditions are intended to represent failure modes of columns

Condition i – flexure failure

Condition ii – flexure-shear failure

Condition iii – shear failure

ASCE 21-06 provides modeling parameters (MP) to generate a non-linear force-displacement (or force-end rotation) backbone curve for RC columns. MP are expressed in terms of plastic rotations. Figure 2.5 illustrates a generalized forced-displacement curve with modeling parameters *a* and *b*. ASCE 41-06 Supplement No.1 defines *a* as the plastic rotation from yield up to significant loss of lateral load capacity (20% reduction in maximum applied lateral load) and *b* as the plastic rotation up to axial failure. Parameter *c* in Figure 2.5 represents residual strength ratio and is beyond the scope of this study.

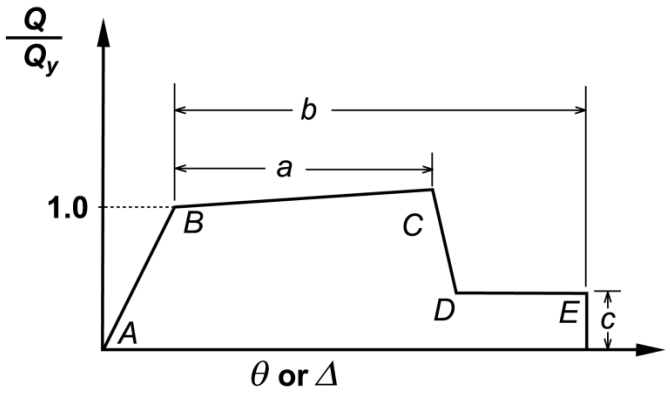


Figure 2.5: Generalized force-displacement or force-rotation backbone curve with modeling parameters *a* and *b* (from ASCE-41-06)

Figure 2.6 presents idealized backbone curve for flexure critical, flexure-shear critical and shear critical columns.

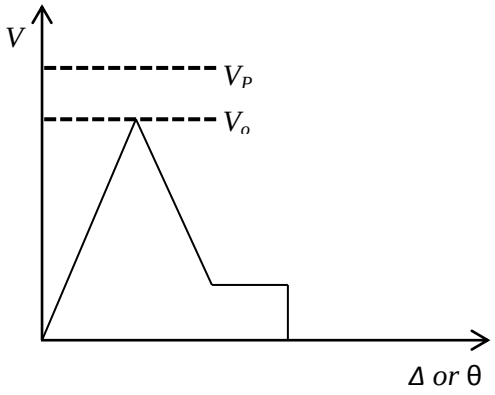


Figure 2.6.a: Idealized backbone curve for shear critical columns

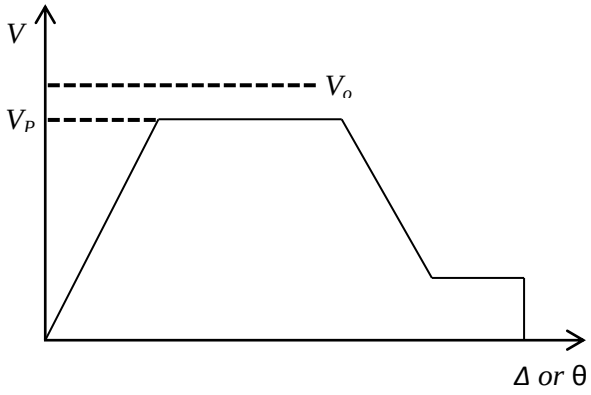


Figure 2.6.b: Idealized backbone curve for flexure-shear critical and flexure critical columns

The table of modeling parameters and acceptance criteria in existing ASCE 41-06 Supplement No.1 provisions is shown in figure 2.7. These modeling parameters were estimated based on target probabilities of failure (P_f) chosen based on consequences of different failure modes. For modeling parameter *a*, P_f of 35% was chosen and for *b*, P_f of 15% was considered.

Acceptance criteria for different target performance level are also presented in Figure 2.7. Five different performance objectives are defined in ASCE 41-06 out of which only three are related to non-linear analysis of reinforced concrete columns as seen in Figure 2.7. These performance objectives represent the target damage state of the structure for a given seismic event. For seismic hazards of varying recurrence periods, different performance objectives are selected.

The target for Immediate Occupancy (*IO*) is very little damage to the structure. Functionality of the structure should remain uninterrupted and the structure is deemed safe to occupy with minimal repairs needed. This performance objective is usually targeted for relatively frequent seismic events.

The Life Safety (*LS*) objective may result in significant damage to occur in a structure in an earthquake. The structure should not collapse or generate loss of life though falling debris for this objective. This performance objective is usually the target for relatively infrequent seismic events; often taken as the design base earthquake.

The Collapse Prevention (*CP*) objective may result in significant damage and only requires the prevention of total collapse. This performance objective is usually targeted for very infrequent seismic events; often taken as the maximum credible earthquake.

In addition to classifying the performance into five levels, ASCE 41-06 also categorizes structural components into primary and secondary components. Primary components form a part of lateral force resisting system. Secondary components take care of just gravity loads and do not take part in lateral force resisting mechanism. Modeling

parameters are the same for primary and secondary elements but acceptance criteria are different.

Users of these provisions develop the backbone curves for all structural elements based on the modeling parameters, simulate the behavior of the structure under a given seismic hazard, record the maximum plastic rotations sustained by the elements, and compare these maximums reached to applicable acceptance criteria. If the maximum rotations are below the acceptance criteria, the column is deemed to perform adequately for the performance objective, otherwise retrofit may be required.

Table 6-8 Modeling Parameters and Numerical Acceptance Criteria for Nonlinear Procedures- Reinforced Concrete Columns

Conditions			Modeling Parameters[3]			Acceptance Criteria[3,4]				
			Plastic Rotations Angle, radians		Residual Strength Ratio	Plastic Rotations Angle, radians				
						Performance Level				
							Component Type			
							Primary		Secondary	
			a	b	c	IO	LS	CP	LS	CP
Condition i. [1]										
$\frac{P}{A_g f'_c}$ [2]	$\rho = \frac{A_v}{b_w s}$									
≤ 0.1	≥ 0.006		0.035	0.060	0.2	0.005	0.026	0.035	0.045	0.060
≥ 0.6	≥ 0.006		0.010	0.010	0.0	0.003	0.008	0.009	0.009	0.010
≤ 0.1	= 0.002		0.027	0.034	0.2	0.005	0.020	0.027	0.027	0.034
≥ 0.6	= 0.002		0.005	0.005	0.0	0.002	0.003	0.004	0.004	0.005
Condition ii. [1]										
$\frac{P}{A_g f'_c}$ [2]	$\rho = \frac{A_v}{b_w s}$	$\frac{V}{b_w d\sqrt{f'_c}}$								
≤ 0.1	≥ 0.006	≤ 3	0.032	0.060	0.2	0.005	0.024	0.032	0.045	0.060
≤ 0.1	≥ 0.006	≥ 6	0.025	0.060	0.2	0.005	0.019	0.025	0.045	0.060
≥ 0.6	≥ 0.006	≤ 3	0.010	0.010	0.2	0.003	0.008	0.009	0.009	0.010
≥ 0.6	≥ 0.006	≥ 6	0.008	0.008	0.2	0.003	0.006	0.007	0.007	0.008
≤ 0.1	≤ 0.0005	≤ 3	0.012	0.012	0.0	0.005	0.009	0.010	0.010	0.012
≤ 0.1	≤ 0.0005	≥ 6	0.006	0.006	0.0	0.004	0.005	0.005	0.005	0.006
≥ 0.6	≤ 0.0005	≤ 3	0.004	0.004	0.0	0.002	0.003	0.003	0.003	0.004
≥ 0.6	≤ 0.0005	≥ 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Condition iii. [1]										
$\frac{P}{A_g f'_c}$ [2]	$\rho = \frac{A_v}{b_w s}$									
≤ 0.1	≥ 0.006		0.0	0.060	0.0	0.0	0.0	0.0	0.045	0.060
≥ 0.6	≥ 0.006		0.0	0.008	0.0	0.0	0.0	0.0	0.007	0.008
≤ 0.1	≤ 0.0005		0.0	0.006	0.0	0.0	0.0	0.0	0.005	0.006
≥ 0.6	≤ 0.0005		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Condition iv. Columns controlled by inadequate development or splicing along the clear height[1]										
$\frac{P}{A_g f'_c}$ [2]	$\rho = \frac{A_v}{b_w s}$									
≤ 0.1	≥ 0.006		0.0	0.060	0.4	0.0	0.0	0.0	0.045	0.060
≥ 0.6	≥ 0.006		0.0	0.008	0.4	0.0	0.0	0.0	0.007	0.008
≤ 0.1	≤ 0.0005		0.0	0.006	0.2	0.0	0.0	0.0	0.005	0.006
≥ 0.6	≤ 0.0005		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 2.7: Values of modeling parameter and acceptance criteria for different conditions (ASCE 41-06 Supplement No.1)

2.7 ATC 58 (2009) Provisions on Performance Based Design

The probabilities of failure mentioned in previous sections are estimated by developing fragility curves. ATC 58 (2009) provisions for building fragility curves are used in this study and summarized briefly. Fragility curves are used to estimate the probability of exceedance of a particular damage level for a structural component given a demand parameter (e.g., peak ground acceleration, story drift, plastic rotations, etc.). Fragility curves for structural components typically represent a cumulative distribution function for a lognormal distribution of the chosen demand parameter. Fragility functions are derived by fitting a lognormal cumulative distribution function to the data. ATC 58 (2009) defines a fragility function mathematically as

$$F_i(D) = \Phi\left(\frac{\ln\left(D/\theta_i\right)}{\beta_i}\right) \tag{2-2}$$

where

$F_i(D)$ – conditional probability that the component will be damaged to the state *i* or a more severe damage state as a function of demand parameter *D*.

Φ – standard normal cumulative distribution function.

θ_i – median value of the probability distribution.

β_i – logarithmic standard deviation.

This procedure is used to develop fragility curves in Chapter 4.

3. COLUMN DATABASE

A database of 171 circular column tests and 319 rectangular column tests was collected. Compiled column tests involved cyclic and monotonic lateral loading of columns; with or without axial load applied. The Pacific Earthquake Engineering Research center (PEER) Structural Database (Berry M. et al., 2004) was a main source for the database, with additional columns introduced from various published reports and manuscripts. The compiled database is divided into circular column and rectangular column sections. Both sections are subdivided into three categories based on either the reported or calculated mode of failure of columns. The modes of failure were described in Chapter 2 and are 1) Flexure, 2) Flexure-shear, and 3) Shear.

All circular columns in the database had circular transverse reinforcement. Only 13 circular columns had circular ties or hoops while the rest had continuous spiral reinforcement (not necessarily conforming to the definition of spiral reinforcements of section 7.10.4 of ACI 318-08). Rectangular columns in database had a mix of non-seismically and seismically detailed rectangular ties (as pre ACI 318 provisions). Data about the detailing of transverse reinforcement was not available for all rectangular columns. Moreover, columns in the database originate from many international sources where seismic detailing of transverse reinforcement may not be same as U.S. practice. For this reason, information regarding seismic detailing of rectangular ties was not introduced in the database. No rectangular columns had circular transverse reinforcement.

Axial failure of test columns was only reported in a relatively small portion of database columns. Whenever columns were tested to axial failure, pertinent information regarding that failure was reported.

Every column is identified by the column name given by the author who tested it and the main author's name. For ease of reporting, column test data was split into two categories

1) Reported data – data directly obtained from test reports
2) Calculated or extracted data – data obtained through calculations and analysis or extracted from force-displacement plots.

3.1 Column Data

Pertinent data used in subsequent chapters are defined next. Appendix A-1 lists all reported and extracted data.

3.1.1 Reported Data

Column Geometry

a) *Shear span (L_a)* = distance between point of maximum moment to point of zero moment.
b) *Effective depth of column section (d)* –is measured as the distance from extreme compression fiber to center of outermost tensile longitudinal reinforcement in the direction of loading for rectangular sections. For circular columns, *d* was taken as 0.8 times the section diameter (as per ACI 318-08).

Axial Loading Details

Only columns that were tested under constant axial load are introduced in the database.

Test Configurations

Three types of test configurations are present in the database.

Test configuration	Database code
Single Cantilever	1
Double Cantilever	2
Double Curvature	3

Table 3.1: Types of test configurations

The test configuration of each column is identified in the database by the code mentioned in Table 3.1. Figure 3.1 illustrates the three test configurations.

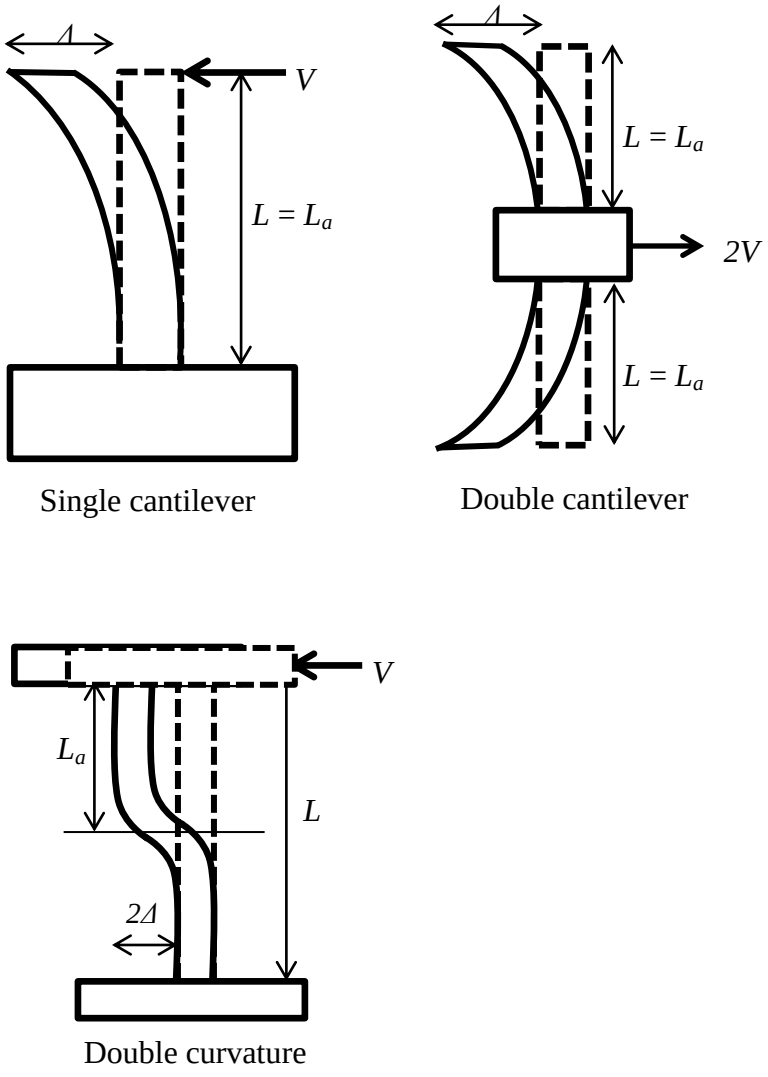


Figure 3.1: Test configurations of database columns

Note: in Figure 3.1, V is the database reported column shear force and Δ is the reported column lateral displacement.

Force Displacement Relations

Complete lateral Force-Displacement (FD) relations for all columns are included in the database. FD values were either obtained from the PEER database, directly from researchers, or digitized from FD plots in source documents. While the numerical values of FD relations could not be presented here, FD relations for all columns are reproduced in Appendix B. It should be noted that FD relations in this database are based on V and Δ illustrated in Figure 3.1.For double cantilever specimens, the reported shear force (V) is the one corresponding to the shear force in either of the columns; which is equal to half the load applied to the specimen (see Figure 3.1).

3.1.2 Calculated or Extracted Data

3.1.2.1 Calculated Data

a) *Shear span to depth ratio* = (L_a/d).

b) *Length of column (L) = clear* distance between supports. L in the database refers to the actual full length of the specimen and not the equivalent single-cantilever column as was mentioned in the PEER database.

c) *Axial load ratio* – as defined in Chapter 2.

d) *Longitudinal reinforcement ratio,* ρ_L (for rectangular columns) = $\frac{A_S}{(b\ h)}$

where, A_S – total area of longitudinal reinforcement in the section, b – section width in the direction perpendicular to loading. It was taken as section diameter for circular columns (as per ACI 318-08), h – section height in the direction of loading.

For circular columns, $\rho_L = \frac{A_S}{\left(\frac{\pi}{4} h^2\right)}$

h – section diameter in the direction of loading.

e) *Sectional transverse reinforcement ratio, ρ''* – as defined in Chapter 2.

f) *Plastic shear demand (V_P)*

Plastic shear demand is the shear demand at the plastic capacity of column flexural hinges.

V_P is calculated as $\left(\frac{M_P}{L_a}\right)$;

where, M_P – column plastic moment strength.

To obtain M_P, the cross-section of each column was divided into 20 concrete fibers and each longitudinal steel bar was treated as a fiber. Hognestad's (1951) parabolic concrete stress-strain relation was used to model the stress-strain behavior of concrete fibers. Contribution of concrete in tension was neglected. For steel fibers, the maximum stress was limited to the yield stress, f_{yl} and a linear stress-strain relation was used to obtain the stresses below f_{yl}. A strain of 0.003 was used for extreme compressive fiber while the neutral axis depth was determined iteratively until internal and external axial loads were in equilibrium (i.e., the internal fiber forces equaled the applied axial load on the column P). Summing the moments of the internal forces generated M_P.

g) *Axial Load and Moment at Balanced Conditions ($P_{b,}$ M_b)*

Balanced axial load and moment are defined as those that generate simultaneously an extreme compression fiber strain of 0.003 and tension steel strain of ε_y (= yield strain). Using the same fiber-section model used to evaluate M_P, sectional analysis with a linear strain profile fixed at 0.003 at the extreme compression fiber and ε_y at the outermost tension steel was used to calculate *($P_{b,}$ M_b)* for database columns.

h) *Ratio of imposed axial load to balanced axial load (P/P_b)*

That ratio is provided as it indicates whether a column was likely to reach its flexural limit through steel yielding or concrete crushing.

i) *Shear Stress Ratio*

It was calculated as $\frac{V_P \; or \; V_o}{b \; d \; \sqrt{f_c'}}$

where the smaller of V_P or *Vo* was used. *Vo* is the column shear strength as defined in Chapter 2. Shear stress ratio represents the maximum normalized shear stress a column is expected to sustain.

Figure 3.2 provides a good overview of the range of key column properties in the database.

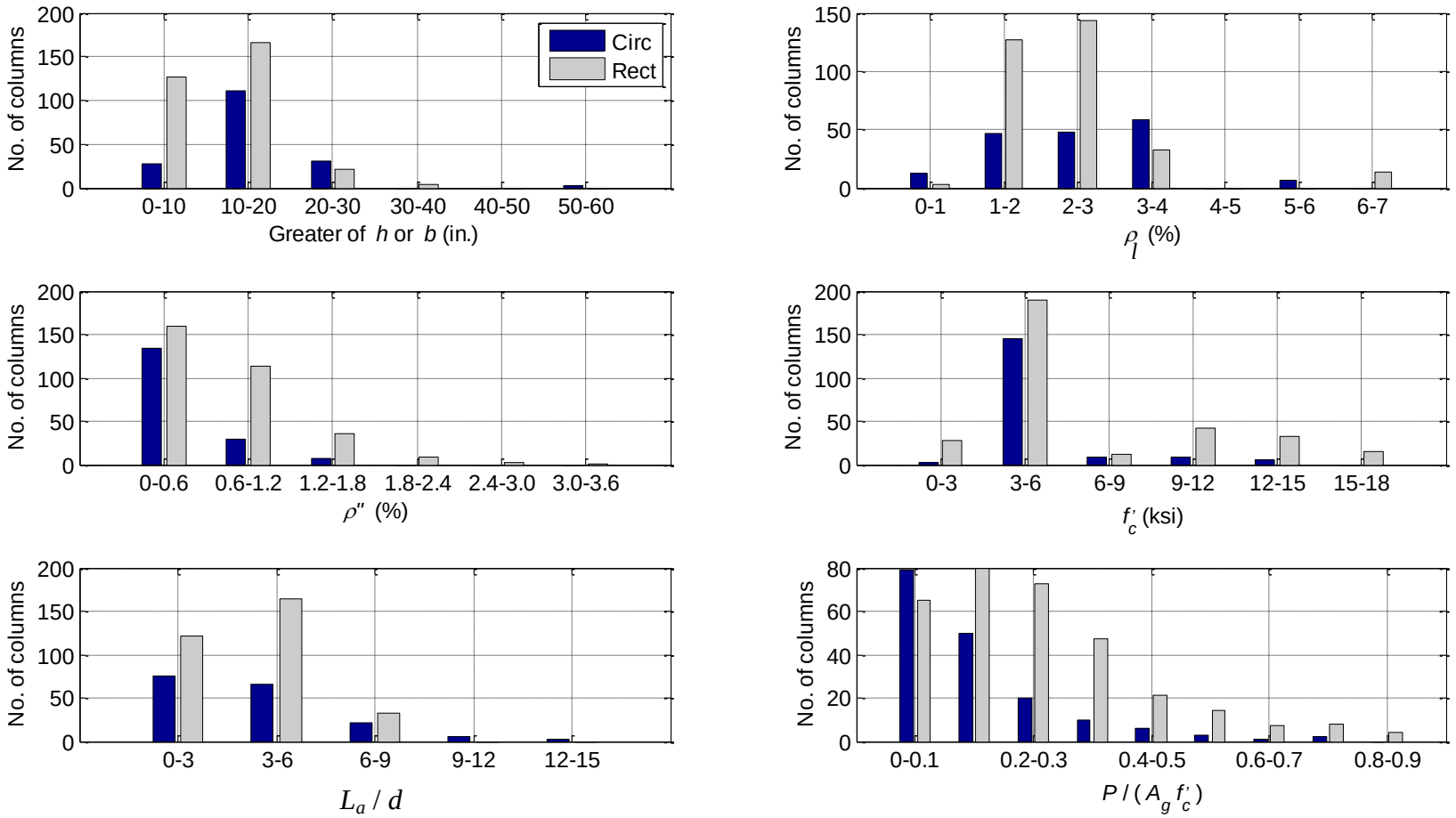


Figure 3.2: Section and loading properties of database rectangular (Rect) and circular (Circ) columns.

3.1.2.2 Extracted Displacement and Load Values in Database

Displacement and load values at which key behavioral milestones are reached were extracted from FD plots for each column. All the values explained next were extracted from loading branches of the FD hysteresis curves. FD plots of all columns with relevant points highlighted (i.e., yield, shear failure, shear failure initiations) are given in Appendix B.

Yield Load and Displacement (V_y and Δ_y)

For flexure critical (FC) and flexure-shear critical (FSC) columns, yield load and displacement were extracted. For shear critical (SC) columns that fail in shear prior to yielding, no such values could be extracted. On a FD plot, a secant is drawn passing through the curve at 0.7 V_{MAX} and made to intersect the horizontal line corresponding to V_{MAX} (Figure 3.3). V_{MAX} is the column maximum attained shear force. A vertical line is then dropped from the point of intersection of the secant and the horizontal line at 0.7 V_{MAX}. Where the vertical line intersects the FD curve is taken as the yield load & displacement. In addition, yield displacement and load values were estimated using an intercept at 0.6 V_{MAX}. A sensitivity study showed little difference in the results derived from using either intercept. Results based on a 0.7 V_{MAX} intercept were used in analyses. Sezen (2004) also found that reasonable accuracy resulted using 0.7 V_{MAX}.

Maximum Applied Lateral Load and Corresponding Displacement (V_{MAX} and Δ_{VMAX})

V_{MAX} and Δ_{VMAX} represent absolute maximum applied lateral load and the corresponding displacement respectively. Using an absolute value accounts for both positive and negative directions of loading.

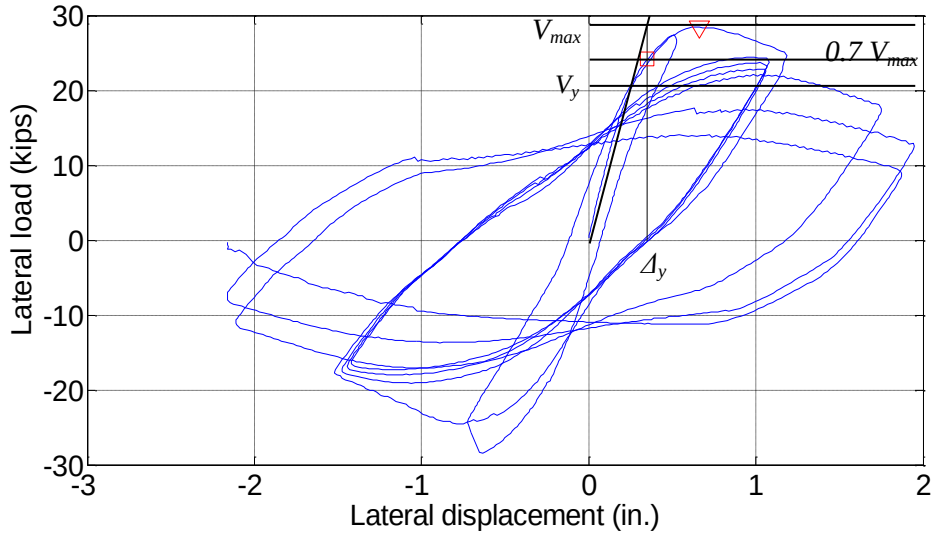


Figure 3.3 Extraction of yield load and displacement values from FD plot

Displacement when Shear Capacity Drops to 80% V_{MAX} ($\Delta_{0.8}$)

The lateral displacement during loading at which the column experienced a 20% reduction in maximum applied lateral load was recorded as $\Delta_{0.8}$. If a 20% drop in shear capacity occurs because of cycling at a constant deformation rather than through increasing deformation demands, then the displacement at 0.8 V_{MAX} was obtained through interpolation by drawing a line connecting tips of hysteresis loops before and after horizontal line at 0.8 V_{MAX} (Figure 3.4). If there was no drop in lateral load to 0.8 V_{MAX}, then $\Delta_{0.8}$ was taken as the maximum lateral displacement the column test achieved. A

lower bound estimate on the lateral displacement at shear failure is obtained with the procedure. Not achieving 20% loss of lateral strength occurred mostly for flexure critical columns. $\Delta_{0.8}$ is used throughout the project as the displacement at which shear failure occurs. At that displacement however, shear degradation is well underway (20% loss of lateral strength) and another measure Δ_S (described next) is defined as displacement at shear failure initiation.

Lateral Displacement and Load at Initiation of Shear Failure (V_S and Δ_S)

The point after which there was degradation of lateral load in subsequent cycles was identified as the shear failure initiation point. In the majority of cases this point corresponded to (V_{MAX} and Δ_{VMAX}). In some flexure critical (FC) columns, a drop in lateral load carrying capacity can occur but the column may be able to maintain the lower level of lateral load without further capacity loss to significantly larger deformations. In such cases the point at which further lateral strength degradation was initiated followed by a steady degradation at larger drifts was used to define the point at which loss of lateral load capacity initiated. If no distinct drop in lateral load was observed, the point at farthest test displacement was considered as the point of initiation of shear failure; which gives a lower bound on the solution.

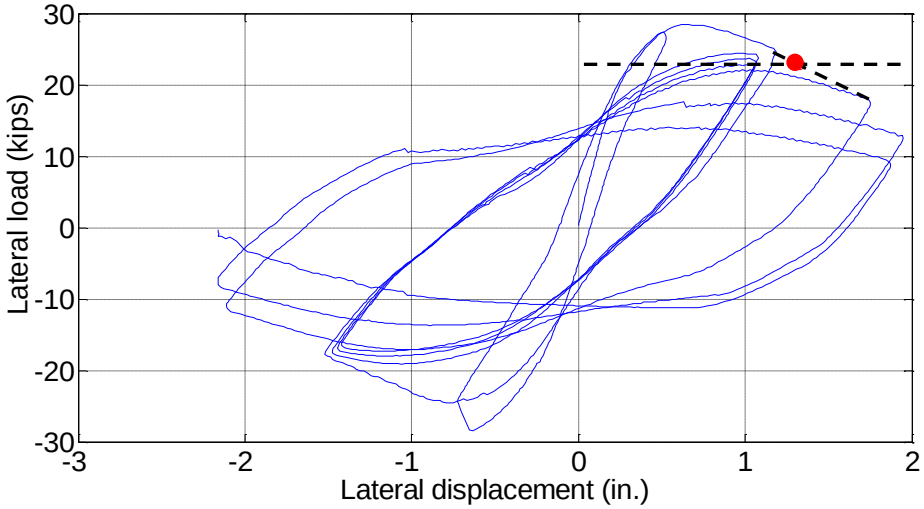


Figure 3.4: Estimation of $\Delta_{0.8}$

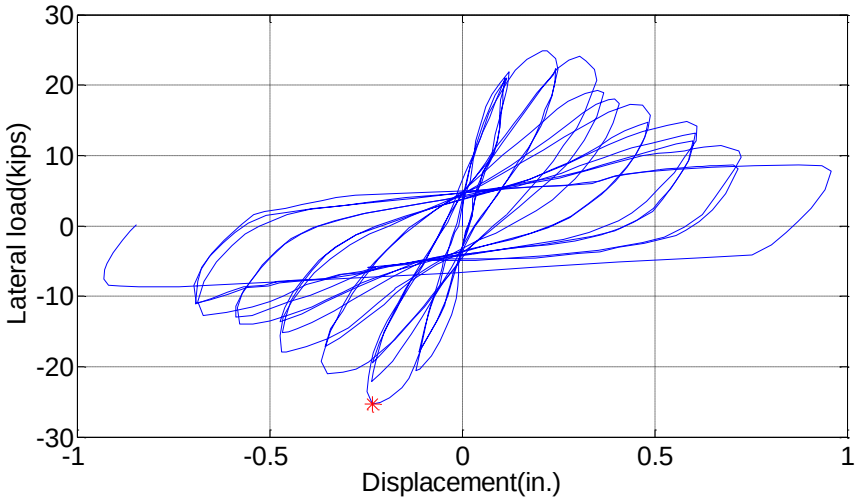


Figure 3.5: F-D plot with shear failure initiation point

Lateral Displacement and Load at Axial Failure of Column

Where lateral displacement and load at axial failure were reported in source documents, they were taken directly from those source documents (Δ_{bR}, V_{bR}). If such values were not reported, then the point at which the lateral load capacity dropped to 25%

of V_{MAX} was recorded as the axial failure point ($\Delta_{b0.25}$, $V_{b0.25}$). It was assumed that columns sustaining that significant a loss of lateral load would have severe damage and axial load carrying capacity may not be maintained much beyond $\Delta_{b0.25}$; particularly when a column is subjected to dynamic loading rather than the pseudo-static loading protocol that all columns in the database were subjected to. The choice of displacement at 25% V_{MAX} was also made to offset any potential errors in reporting of axial failure. If no drop to 25% V_{MAX} was observed, then the maximum lateral displacement and corresponding lateral load were recorded as values at axial failure (Δ_{bmax}, V_{bmax}). According to that prioritization scheme, a new variable named "prioritized" lateral displacement (Δ_{bP}) was defined by selecting displacement values in the aforementioned order. A conditional loop is presented below to better explain the prioritization scheme.

If Δ_{bR} exists, $\Delta_{bP} = \Delta_{bR}$

Else if $\Delta_{b0.25}$ exists, $\Delta_{bP} = \Delta_{b0.25}$

Else $\Delta_{bP} = \Delta_{bmax}$

Plastic Rotation at Shear Failure (a)

Plastic rotation at shear failure *(a)* is defined as the plastic rotation that a column plastic hinge undergoes between Δ_y and $\Delta_{0.8}$

$$a = \frac{(\Delta_{0.8} - \Delta_y)}{L} \tag{4-2}$$

For shear critical (SC) columns *a* was set to zero.

Plastic Rotations at Axial Failure (b_P, b_R)

b_P represents the plastic rotation that a column plastic hinge undergoes between Δ_y and Δ_{bP}

$$b_P = a + \frac{(\Delta_{bP} - \Delta_{0.8})}{L} \quad (4\text{-}3)$$

b_R represents the plastic rotation that a column plastic hinge undergoes between Δ_y and Δ_{bR}

$$b_R = a + \frac{(\Delta_{bR} - \Delta_{0.8})}{L} \quad (b_R \text{ is a subset of } b_P) \quad (4\text{-}4)$$

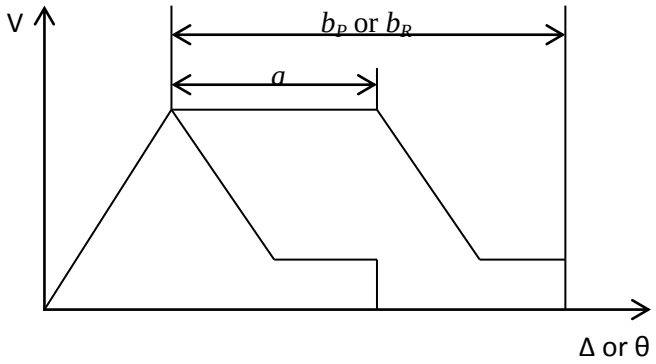


Figure 3.6: Force-displacement curves with plastic rotations

Plastic rotations *a* and b_P or b_R are used in ASCE 41-06 to define the idealized force-deformation backbone curve for column elements (Figure 3.6). The idealized force-displacement curve for shear critical and flexure-shear critical columns is illustrated in figure 3.6. Note, the plastic rotation (*a*) is zero for shear-critical columns.

3.2 Binning of Database Columns

Classification by Behavior

It was challenging to classify columns into three categories according to their modes of failure; particularly when little data was available other than force-deformation plots and basic column dimensions and properties. The PEER database methodology (Berry et al., 2004) was selected for classifying columns with minor modifications.

If the ductility demand $\mu_s=(\Delta_{0.8}-\Delta_y)/\Delta_y$ at the point of shear failure is greater than 6, and no shear damage was reported, the column is classified as flexure critical (FC). If μ_s is less than 2, or $Vo \leq V_P$, or the original documentation specifically mentions that flexural yielding did not occur prior to shear failure, then a column is classified as shear critical (or SC). Otherwise, a column is classified as flexure-shear critical (FSC). These three modes of failure are identified in the database by the code mentioned in Table 3.2.

Failure mode	Database code
Flexure	1
Flexure-shear	2
Shear	3

Table 3.2: Types of failure modes

Classification According to ASCE-41-06 Supplement 1 Methodology

Database columns were globally binned into three conditions namely i, ii, iii based on V_P / V_o values according to ASCE 41-06 Supplement 1 Methodology. Chapter 2 contains more detail about that methodology. Please note that condition i should correspond to FC columns, condition ii should correspond to FSC columns, and condition iii should

correspond to SC columns. To verify that categorization methodology, Figure 3.7 was plotted with the number of columns of different categories (i.e., FC, FSC, SC) that are binned using ASCE 41-06 procedures into the three conditions (i, ii, iii). The plots show that ASCE 41-06 methodology bins columns into conditions that generally match failure categories that represent the best estimate of actual column behavior.

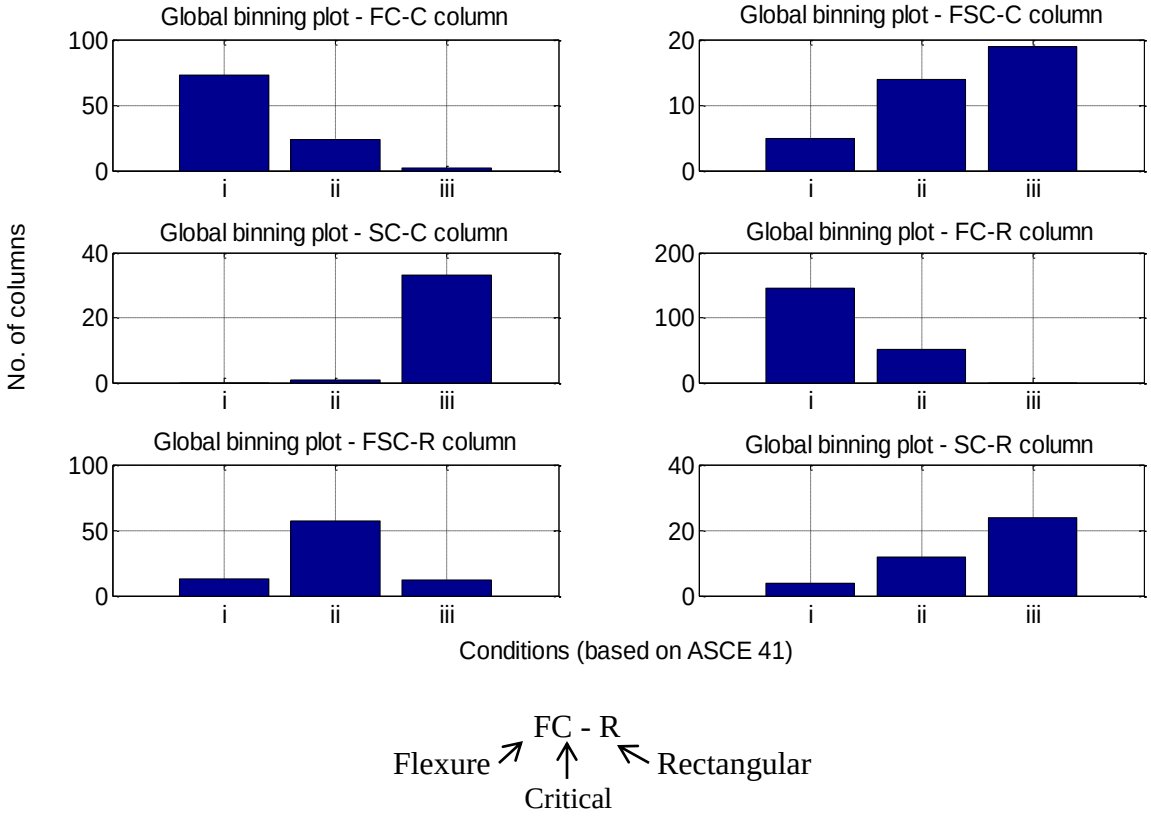


Figure 3.7: Binning of different categories of columns based on ASCE 41-06

4. REVISIONS TO MODELING PARAMETERS

The database of 319 rectangular and 171 circular columns has been used to propose revisions to the existing modeling parameters (MP) for non-linear procedures for reinforced concrete columns (ASCE 41-06 Supplement No.1). A shift from conservative estimates of modeling parameters to median estimates (probability of failure of 50%) is proposed in this study. Initially, circular column data was collected to verify whether current ASCE 41 provisions that are based only on rectangular column data were valid for circular columns. Substantial differences in rotation capacities were noted between rectangular and circular columns, likely due to the use of spiral reinforcement in circular columns as opposed to mostly non-seismically detailed hoops in rectangular columns. Therefore circular column MP values were derived separately and are introduced.

4.1 Modeling Parameters

ASCE 41-06 provisions specify a simplified force-displacement backbone curve for modeling the non-linear lateral behavior of elements (Figure 4.1). Modeling parameters *a* and *b* represent plastic rotation *a* at shear failure and plastic rotation b_P or b_R at axial failure as (Chapter 3). Recall that two different plastic rotations at axial failure were extracted for each column in the database (b_P, b_R) as described in Chapter 3. b_R is obtained only for columns that were tested to axial collapse and where lateral deformations at axial failure were recorded. b_P provides a value for all columns regardless if there were tested to collapse or not and thus provides a lower bound on the

true parameter. Parameter *c* represents residual strength ratio of the column and is beyond the scope of this study.

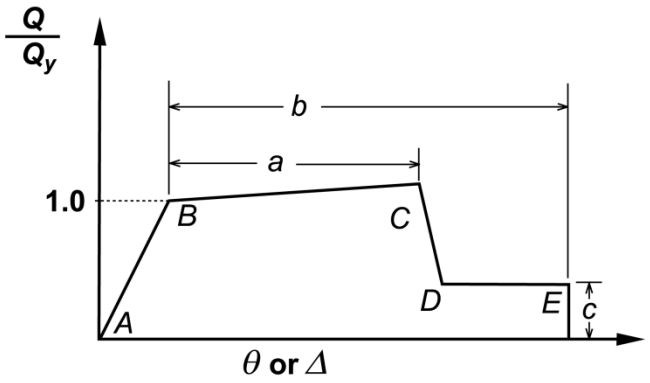


Figure 4.1: Force-displacement backbone curve with modeling parameters (Figure 2.5 reproduced for easy reference).

4.2 Current ASCE 41-06 Provisions and Objective of Revision

Values of existing modeling parameters *a* and *b* in ASCE 41-06 (Supplement no.1) for reinforced concrete columns are based on probabilities of failures of 35% and 15% respectively. These target probabilities of failure were a result of revisions proposed by Elwood et al. (*Update to ASCE/SEI 41 Concrete Provisions*, 2007) to modeling parameters and acceptance criteria in ASCE/SEI 41 for various structural components. It is mentioned in the document that the probabilities of failure of 35% and 15% were chosen based on judgment regarding the consequence of each failure mode (Chapter 2). The various elements treated in ASCE 41-06-Supplement No. 1 (columns, beams, walls etc.) currently have their MP defined using varying levels of conservatism. The processes by which parameters for various elements were derived are not properly documented such that the variations in conservatism of modeling parameters cannot be evaluated for

current provisions. Such uneven conservatism across element MP in a structure can generate a prediction of an artificial failure mechanism that is quite different from the most likely mechanism. When simulating the behavior of a structure within the performance-based framework, it is best to get the best estimate of the response. Thus it is proposed here to consider median estimates of modeling parameters (corresponding to a probability of failure of 50%). Conservatism in this approach is only introduced in the acceptance criteria depending on the target performance objective and a particular failure mode. In certain cases, a small change in the MP of an element can result in a large change in the overall failure mechanism of a structure. To allow users of the new MP to perform sensitivity analyses, it is the intent of work to provide not only new MP values but also a measure of the spread in the data. Figure 4.2 shows Table 6-8 of ASCE 41-06 Supplement no.1 which provides values for modeling parameters *a* and *b* for conditions i, ii, iii and iv. Condition iv, not considered in this work, is a condition that groups columns with inadequate splice details.

4.3 Updates to Modeling Parameters

4.3.1 Identification of Key Parameters Influencing Plastic Rotations *a* and *b*

Main parameters considered were Axial Load Ratio $\left(\frac{P}{A_g f_c'}\right)$, Transverse Reinforcement Ratio (ρ''), Shear Stress Ratio $\left(\frac{V}{b\ d\ \sqrt{f_c'}}\right)$, Shear Span to Depth Ratio $\left(\frac{L_a}{d}\right)$, ratio of applied axial load to balanced axial load $\left(\frac{\mathrm{P}}{\mathrm{P_b}}\right)$ and ratio of plastic shear

demand to shear strength $\left(\frac{V_P}{V_o}\right)$. Influence of each parameter on plastic rotations *a* and *b* is shown through scatter plots in Figures 4.3 to 4.6. As observed in the plots, $\left(\frac{P}{A_g f_c'}\right)$ and $\left(\frac{V}{b\ d\ \sqrt{f_c'}}\right)$, $\left(\frac{P}{P_b}\right)$, $\left(\frac{V_P}{V_o}\right)$ appear to be negatively correlated with plastic rotations *a* and *b*. $\left(\frac{V_P}{V_o}\right)$ shows the clearest trend of all parameters and is represented in ASCE 41 provisions through the binning of column into separate conditions. Transverse reinforcement (*ρ")* is positively correlated with plastic rotations *a* and *b*. This trend is not surprising as higher amounts of transverse reinforcement will tend to increase lateral load capacity, increase resistance across the critical shear crack, and add confinement. $\left(\frac{L_a}{d}\right)$ shows clear positive correlation with both plastic rotations for circular columns but shows little or no correlation in rectangular columns. In Figure 4.5, three outlier points are found in the $\left(\frac{V_P}{V_o}\right)$ plot. These outliers show an increase in b_R values with increasing $\left(\frac{V_P}{V_o}\right)$. No rational explanation could be found for this observation.

Though $\left(\frac{P}{A_g f_c'}\right)$, *ρ"* and $\left(\frac{V}{b\ d\ \sqrt{f_c'}}\right)$ are not the only influencing parameters, they were chosen as parameters for regression as they capture the essential influential parameters and maintain consistency with existing ASCE 41 provisions. A similar tabular format is selected for the proposed MP for consistency with current ASCE provisions. In the future it is possible to apply statistical analysis using compiled data to provide simple equations for MP rather than tables.

Table 6-8 Modeling Parameters and Numerical Acceptance Criteria for Nonlinear Procedures- Reinforced Concrete Columns

Conditions			Modeling Parameters[3]			Acceptance Criteria[3,4]				
			Plastic Rotations Angle, radians		Residual Strength Ratio	Plastic Rotations Angle, radians				
						Performance Level				
							Component Type			
							Primary		Secondary	
			a	b	c	IO	LS	CP	LS	CP
Condition i. [1]										
$\frac{P}{A_g f'_c}$ [2]	$\rho = \frac{A_v}{b_w s}$									
≤ 0.1	≥ 0.006		0.035	0.060	0.2	0.005	0.026	0.035	0.045	0.060
≥ 0.6	≥ 0.006		0.010	0.010	0.0	0.003	0.008	0.009	0.009	0.010
≤ 0.1	= 0.002		0.027	0.034	0.2	0.005	0.020	0.027	0.027	0.034
≥ 0.6	= 0.002		0.005	0.005	0.0	0.002	0.003	0.004	0.004	0.005
Condition ii. [1]										
$\frac{P}{A_g f'_c}$ [2]	$\rho = \frac{A_v}{b_w s}$	$\frac{V}{b_w d\sqrt{f'_c}}$								
≤ 0.1	≥ 0.006	≤ 3	0.032	0.060	0.2	0.005	0.024	0.032	0.045	0.060
≤ 0.1	≥ 0.006	≥ 6	0.025	0.060	0.2	0.005	0.019	0.025	0.045	0.060
≥ 0.6	≥ 0.006	≤ 3	0.010	0.010	0.2	0.003	0.008	0.009	0.009	0.010
≥ 0.6	≥ 0.006	≥ 6	0.008	0.008	0.2	0.003	0.006	0.007	0.007	0.008
≤ 0.1	≤ 0.0005	≤ 3	0.012	0.012	0.0	0.005	0.009	0.010	0.010	0.012
≤ 0.1	≤ 0.0005	≥ 6	0.006	0.006	0.0	0.004	0.005	0.005	0.005	0.006
≥ 0.6	≤ 0.0005	≤ 3	0.004	0.004	0.0	0.002	0.003	0.003	0.003	0.004
≥ 0.6	≤ 0.0005	≥ 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Condition iii. [1]										
$\frac{P}{A_g f'_c}$ [2]	$\rho = \frac{A_v}{b_w s}$									
≤ 0.1	≥ 0.006		0.0	0.060	0.0	0.0	0.0	0.0	0.045	0.060
≥ 0.6	≥ 0.006		0.0	0.008	0.0	0.0	0.0	0.0	0.007	0.008
≤ 0.1	≤ 0.0005		0.0	0.006	0.0	0.0	0.0	0.0	0.005	0.006
≥ 0.6	≤ 0.0005		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Condition iv. Columns controlled by inadequate development or splicing along the clear height[1]										
$\frac{P}{A_g f'_c}$ [2]	$\rho = \frac{A_v}{b_w s}$									
≤ 0.1	≥ 0.006		0.0	0.060	0.4	0.0	0.0	0.0	0.045	0.060
≥ 0.6	≥ 0.006		0.0	0.008	0.4	0.0	0.0	0.0	0.007	0.008
≤ 0.1	≤ 0.0005		0.0	0.006	0.2	0.0	0.0	0.0	0.005	0.006
≥ 0.6	≤ 0.0005		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 4.2: Existing modeling parameters and acceptance criteria in ASCE 41-06 Supplement No.1 (Figure 2.7 reproduced for easy reference)

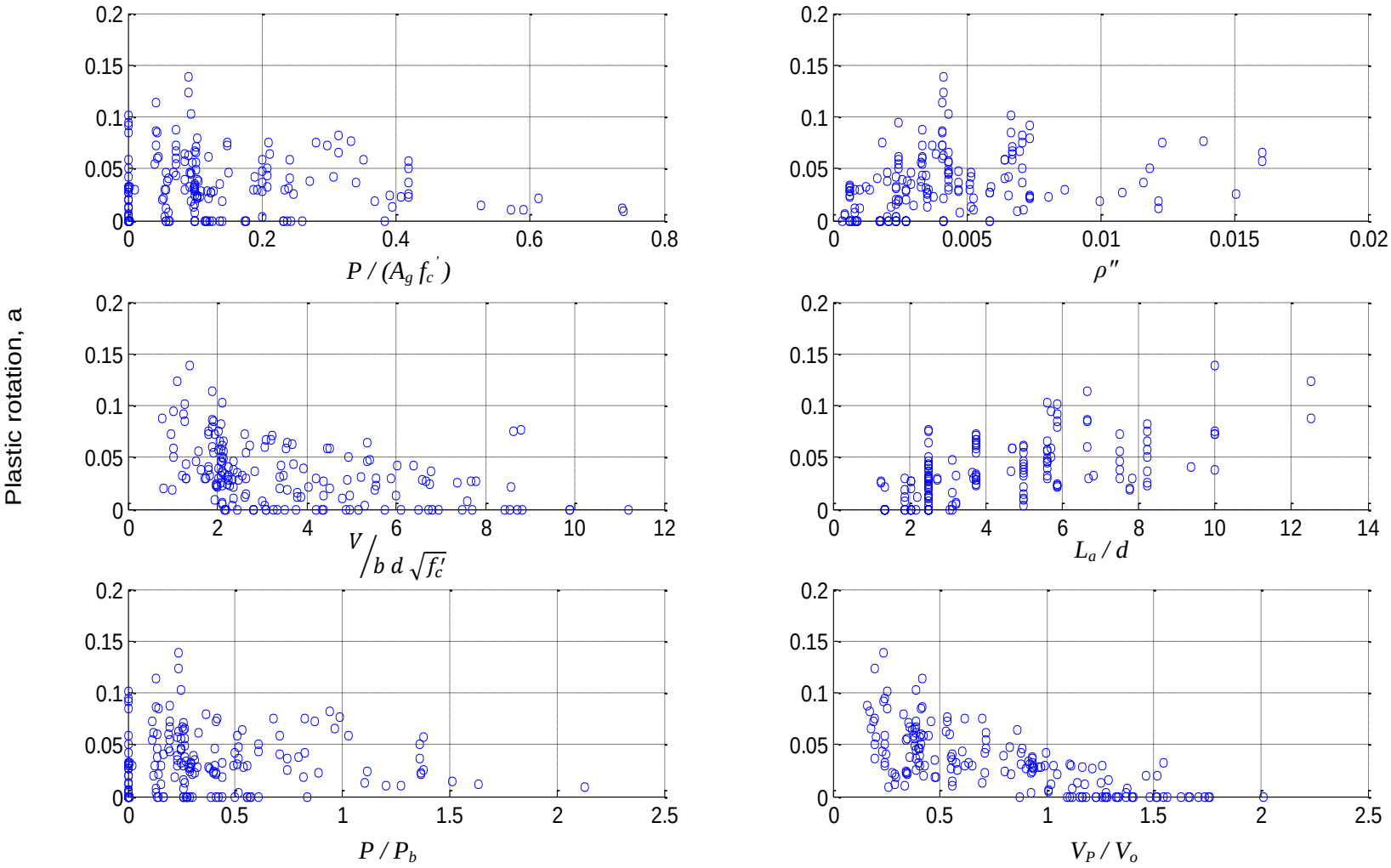


Figure 4.3: Plastic rotation (*a*) vs column properties (circular columns – for all conditions)

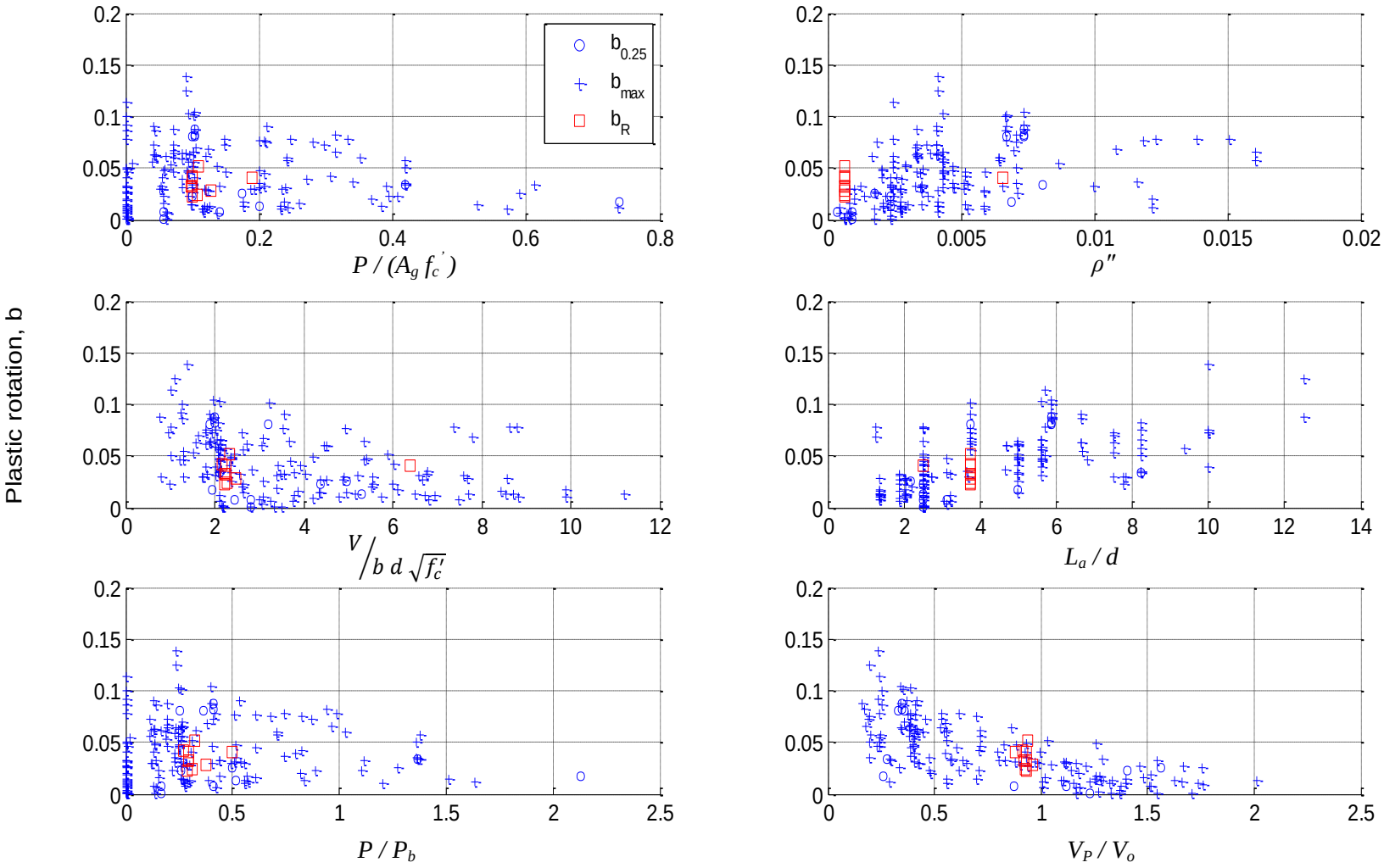


Figure 4.4: Plastic rotation (*b*) vs column properties (circular columns – for all conditions)

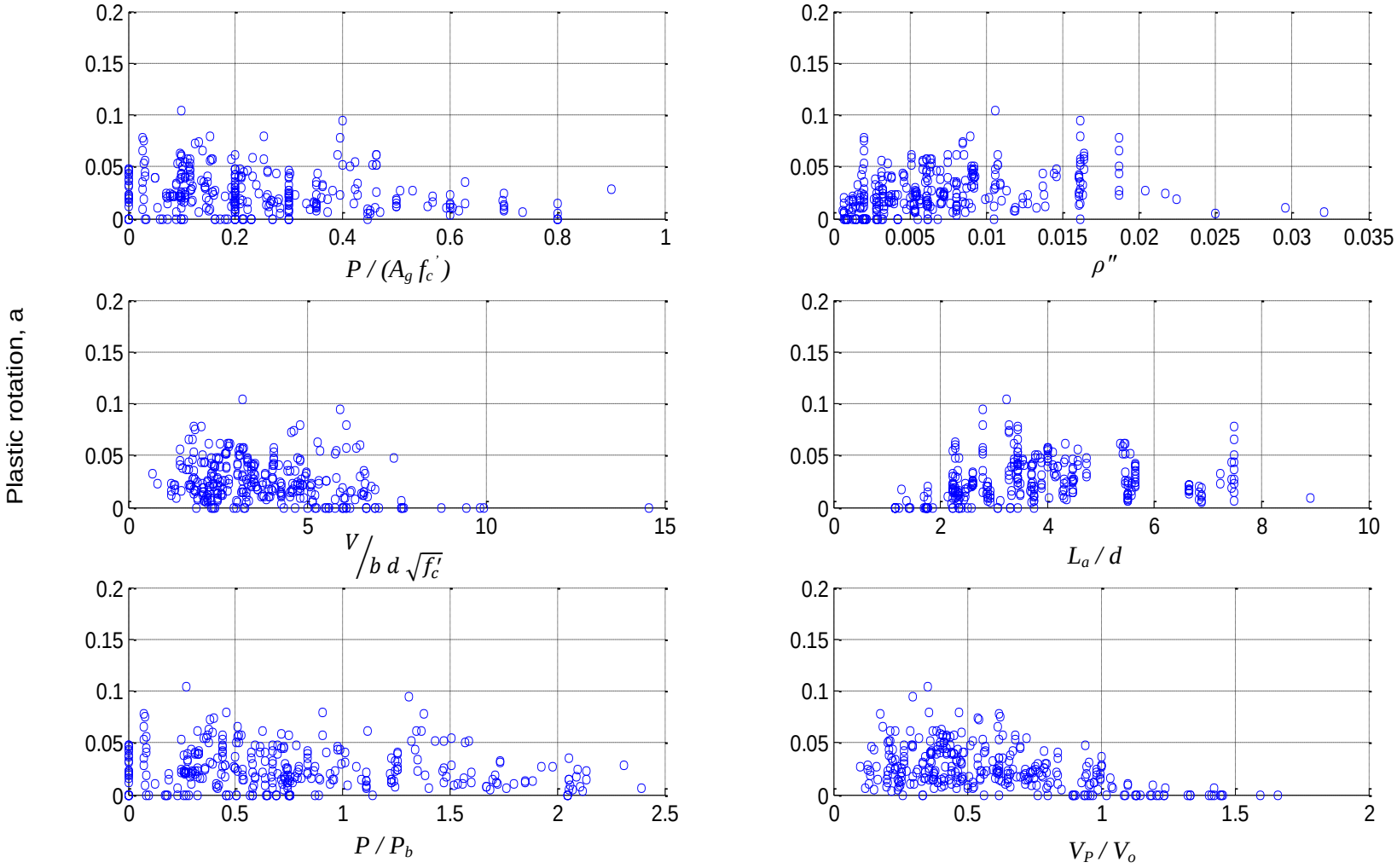


Figure 4.5: Plastic rotation (*a*) vs column properties (rectangular columns – for all conditions)

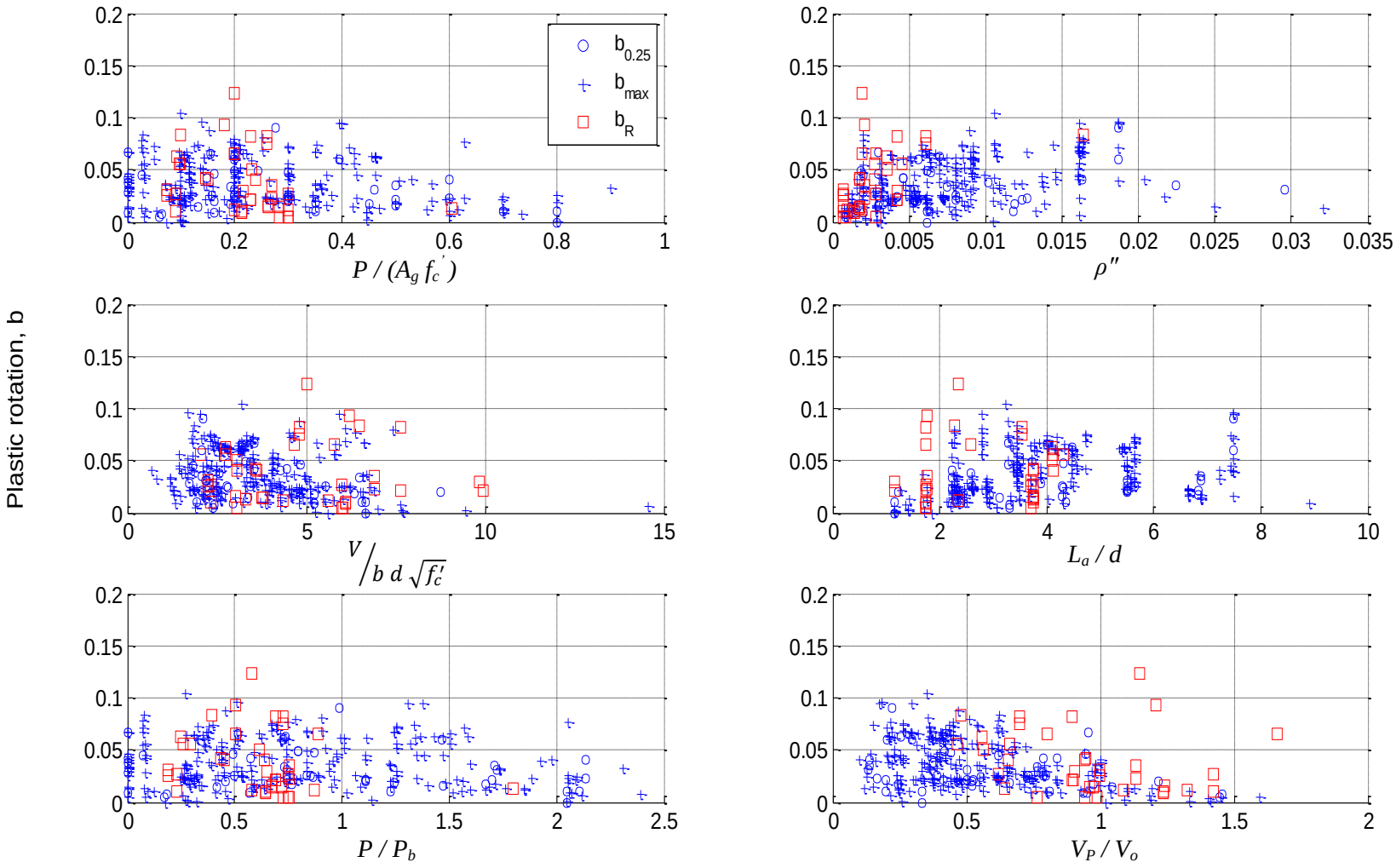


Figure 4.6: Plastic rotation (*b*) vs column properties (rectangular columns – for all conditions)

4.3.2 Linear Regression of Parameters and Plastic Rotations

To replace MP values in Figure 4.2, linear regression was performed to establish a relation between the chosen parameters and plastic rotations as linear regression can provide a good estimate for median values. Regressions were performed separately for plastic rotations *a* and *b* for each of the three condition i, ii, iii. For condition i and iii, $\left(\frac{P}{A_g f_c'}\right)$ and ρ'' were used as independent parameters for regression. For condition ii, $\left(\frac{P}{A_g f_c'}\right)$, ρ'' and $\left(\frac{V}{b\ d\ \sqrt{f_c'}}\right)$ were made use of. These are the parameters currently used in ASCE 41 provisions. Regression coefficients obtained for both circular and rectangular columns are listed in tables 4.1 and 4.2. For condition iii rectangular columns, ρ'' was not considered as a regression parameter for b_R due to heavy clustering of the data. For the most part, regression coefficients followed observed trends in the data.

4.3.3 Development of New Set of Modeling Parameters

Regression coefficients were then used to develop a new set of modeling parameters (Table 4.3). For each bin in each condition (refer to Figure 4.2), corresponding limiting $\left(\frac{P}{A_g f_c'}\right)$, ρ'' and $\left(\frac{V}{b\ d\ \sqrt{f_c'}}\right)$ values were used to calculate the median estimates of modeling parameters from regression equations. The linear regression resulted in some unreasonable estimates of modeling parameters (for b_R) for some bins in condition ii. It can be attributed to the presence of only very few columns in those bins. These values were then manually adjusted based on the estimated and existing

MP values in other bins. As mentioned in the previous chapter, plastic rotation *a* was taken as zero for shear-critical columns. Through binning in ASCE 41 conditions however, most of the shear-critical columns got binned into condition iii, few flexure-critical, and some flexure-shear critical columns also got binned into condition iii. Hence after linear regression, initial estimate of values of modeling parameter (*a*) for condition iii were close to but not zero (Table 4.3).

	Condition i			Condition ii				Condition iii		
Rotations	Constant	$P / A_g f_c'$	ρ''	Constant	$P / A_g f_c'$	ρ''	$V / b\, d\sqrt{f_c'}$	Constant	$P / A_g f_c'$	ρ''
a	0.06472	-0.07133	0.08179	0.03804	0.00617	6.88444	-0.00639	0.00406	-0.02546	2.16625
b_P	0.06758	-0.09152	1.78479	0.04682	-0.00228	7.59331	-0.00797	0.00737	-0.00292	3.69476
b_R	-	-	-	0.05307	-0.04301	7.57462	-0.00832	-	-	-

Table 4.1: Regression coefficients for plastic rotations of circular columns

	Condition i			Condition ii				Condition iii		
Rotations	Constant	$P / A_g f_c'$	ρ''	Constant	$P / A_g f_c'$	ρ''	$V / b\, d\sqrt{f_c'}$	Constant	$P / A_g f_c'$	ρ''
a	0.04163	-0.04849	0.55871	0.02805	-0.02584	2.42378	-0.00281	0.00620	-0.01041	0.20718
b_P	0.05109	-0.05793	1.13758	0.03621	-0.04079	2.49424	-0.00168	0.01335	0.05020	-0.22241
b_R	0.05789	-0.06529	1.96863	0.03761	-0.07007	13.95737	-0.00485	0.04753	-0.05393	-

Table 4.2: Regression coefficients for plastic rotations of rectangular columns

ASCE 41-condition i		Existing parameters		Rectangular columns			Circular columns		
$P / A_g f_c'$	ρ''	a	b	a	b_P	b_R	a	b_P	b_R
<=0.1	>=0.006	0.0350	0.0600	0.0401	0.0521	0.0632	0.0581	0.0691	0.0000
>=0.6	>=0.006	0.0100	0.0100	0.0159	0.0232	0.0305	0.0224	0.0234	0.0000
<=0.1	0.002	0.0270	0.0340	0.0379	0.0476	0.0553	0.0577	0.0620	0.0000
>=0.6	0.002	0.0050	0.0050	0.0137	0.0186	0.0227	0.0221	0.0162	0.0000

ASCE 41-condition ii			Existing parameters		Rectangular columns			Circular columns		
$P / A_g f_c'$	ρ''	$V / b\, d\sqrt{f_c'}$	a	b	a	b_P	b_R	a	b_P	b_R
<=0.1	>=0.006	<=3	0.0320	0.0600	0.0316	0.0421	0.0998	0.0608	0.0682	0.0693
<=0.1	>=0.006	>=6	0.0250	0.0600	0.0231	0.0370	0.0852	0.0416	0.0443	0.0443
>=0.6	>=0.006	<=3	0.0100	0.0100	0.0187	0.0217	0.0648	0.0639	0.0671	0.0478
>=0.6	>=0.006	>=6	0.0080	0.0080	0.0102	0.0166	0.0502	0.0447	0.0432	0.0228
<=0.1	<=0.0005	<=3	0.0120	0.0120	0.0182	0.0283	0.0230	0.0229	0.0265	0.0276
<=0.1	<=0.0005	>=6	0.0060	0.0060	0.0098	0.0233	0.0085	0.0038	0.0026	0.0027
>=0.6	<=0.0005	<=3	0.0040	0.0040	0.0053	0.0079	0.0060	0.0260	0.0253	0.0061
>=0.6	<=0.0005	>=6	0.0000	0.0000	0.0000	0.0029	0.0000	0.0069	0.0014	0.0000

ASCE 41-condition iii		Existing parameters		Rectangular columns			Circular columns		
$P / A_g f_c'$	ρ''	a	b	a	b_P	b_R	a	b_P	b_R
<=0.1	>=0.006	0.0000	0.0600	0.0064	0.0170	0.0421	0.0145	0.0293	0.0000
>=0.6	>=0.006	0.0000	0.0080	0.0012	0.0421	0.0152	0.0018	0.0278	0.0000
<=0.1	<=0.0005	0.0000	0.0060	0.0053	0.0183	0.0421	0.0026	0.0089	0.0000
>=0.6	<=0.0005	0.0000	0.0000	0.0001	0.0434	0.0152	0.0000	0.0075	0.0000

Table 4.3: Modeling parameters – initial estimation based on regression.

4.3.4 Adjustment of MP Tables

After values in Table 4.3 were produced, they needed to be manually adjusted for several reasons: 1) to avoid inconsistencies between conditions (e.g., a condition i column having a lower rotation capacity than a condition ii column with similar parameters); 2) to avoid inconsistencies within the same condition; 3) to ensure that MP values represent the median of the data across the full range of parameters. To verify the last point, columns in the database were further subdivided into bins within each condition. These bins split the column according to high and low parameter ranges.

Condition i and iii were divided into four bins each based on $P / (A_g f_c')$ and ρ'' values.

Bin 1: $0 \le P / (A_g f_c') \le 0.3$ and $0 \le \rho'' \le 0.003$	**Bin 2:** $P / (A_g f_c') > 0.3$ and $\rho'' > 0.003$
Bin 3: $0 \le P / (A_g f_c') \le 0.3$ and $\rho'' > 0.003$	**Bin 4:** $P / (A_g f_c') > 0.3$ and $0 \le \rho'' \le 0.003$

Condition ii was divided into 8 bins based on $P / (A_g f_c')$, ρ'', $V / b\, d \sqrt{f_c'}$ values

Bin 1: $0 \le P / (A_g f_c') \le 0.3$ and $0 \le \rho'' \le 0.003$ and $0 \le V / b\, d \sqrt{f_c'} \le 3$
Bin 2: $P / (A_g f_c') > 0.3$ and $0 \le \rho'' \le 0.003$ and $0 \le V / b\, d \sqrt{f_c'} \le 3$
Bin 3: $0 \le P / (A_g f_c') \le 0.3$ and $\rho'' > 0.003$ and $0 \le V / b\, d \sqrt{f_c'} \le 3$
Bin 4: $P / (A_g f_c') > 0.3$ and $\rho'' > 0.003$ and $0 \le V / b\, d \sqrt{f_c'} \le 3$
Bin 5: $0 \le P / (A_g f_c') \le 0.3$ and $0 \le \rho'' \le 0.003$ and $V / b\, d \sqrt{f_c'} > 3$

Bin 6: $P / (A_g f_c') > 0.3$ and $0 \leq \rho'' \leq 0.003$ and $V / b\,d\,\sqrt{f_c'} > 3$
Bin 7: $0 \leq P / (A_g f_c') \leq 0.3$ and $\rho'' > 0.003$ and $V / b\,d\,\sqrt{f_c'} > 3$
Bin 8: $P / (A_g f_c') > 0.3$ and $\rho'' > 0.003$ and $V / b\,d\,\sqrt{f_c'} > 3$

Fragility curves were developed for Plastic Rotation Ratios (PRR) for columns in each bin of the three conditions. PRR is the ratio of measured plastic rotation to plastic rotation evaluated using modeling parameter tables. PRR values based on newly developed tables and existing tables were evaluated for comparison purposes. For a given column, a PRR value of 1 indicates that the estimated plastic rotation is equal to the experimental value. A PRR value lower than 1 indicates that the plastic rotation is over estimated while a value greater than 1 indicates underestimation of the rotation.

Fragility functions were fit through the data as per ATC 58 (2009) procedures. Fragility functions are lognormal cumulative distribution functions used to characterize the level of damage of a component, element, or system in terms of probability of failure as a function of a demand parameter. In our study PRR was used as the demand parameter. To achieve median modeling parameters, the probability of failure corresponding to a PRR value of 1 should be 0.5 (50%) (i.e., 50% of column data should have a PRR lower than 1 and 50% a PRR higher than 1). This was checked for columns in each bin and modeling parameter tabular values were adjusted accordingly. Table 4.4

gives the final modeling parameter table after manual adjustments were made. As can be seen in this table, new rectangular column *a* values are slightly larger than existing ones, which was expected given that existing values were intended to give a conservative estimate on MP while new values intend to give median values. Circular column MP values are significantly larger than rectangular column values and this trendmay be attributed to the beneficial effects of spiral reinforcements (all circular columns contained spiral reinforcements). b_R values for both rectangular and circular columns are significantly higher than b_P values. This trend is also expected as b_R values are based on column tests where columns were pushed to axial collapse, while b_P values were often based on the maximum drift a test was pushed to when collapse was not achieved. b_P values however are based on significantly more test results than b_R values.

Fragility curves overlaid on the cumulative distribution function (CDF) of the data are plotted in figures 4.7 to 4.14. Please note that fragility curves were developed only for bins that had columns in them. In some bins, limited column numbers generated unrealistic fragility curves; they are plotted nonetheless for completeness. As can be seen from these figures the 50% probability of failure is located for the most part at approximately a PRR value of 1. These Figures also illustrate the variability in rotation estimates. The steeper the fragility curve, the less spread in the estimates or better the estimation of experimental results based on table values. When comparing fragility curves for new tables and old tables, one can note that new table fragility curves are usually steeper indicating that new table values provide a better estimate for MP. These

Figures also provide valuable information about the number of experimental column results in any particular bin. This information can give users a better idea of the applicability of table values to any given column they may be interested in.

Further verification of the table values was made by plotting PRR values versus each parameter for each condition (Figure 4.15 to 4.20). These plots show that values are about evenly distributed above and below the PRR value of 1. The plots also show a "uniform" spread of the data across all parameter ranges indicating that the median estimate was achieved across those ranges.

ASCE 41-condition I		Existing parameters		Rectangular columns			Circular columns		
$P / A_g f_c'$	ρ''	a	b	a	b_P	b_R	a	b_P	b_R*
<=0.1	>=0.006	0.0350	0.0600	0.0390	0.0520	0.0700	0.0595	0.0770	0.0000
>=0.6	>=0.006	0.0100	0.0100	0.0130	0.0190	0.0305	0.0185	0.0205	0.0000
<=0.1	0.002	0.0270	0.0340	0.0370	0.0440	0.0570	0.0395	0.0485	0.0000
>=0.6	0.002	0.0050	0.0050	0.0115	0.0165	0.0227	0.0165	0.0180	0.0000

ASCE 41-condition II			Existing parameters		Rectangular columns			Circular columns		
$P / A_g f_c'$	ρ''	$V / b\, d\sqrt{f_c'}$	a	b	a	b_P	b_R	a	b_P	b_R
<=0.1	>=0.006	<=3	0.0320	0.0600	0.0320	0.0500	0.0690	0.0470	0.0550	0.0695
<=0.1	>=0.006	>=6	0.0250	0.0600	0.0290	0.0350	0.0685	0.0420	0.0430	0.0690
>=0.6	>=0.006	<=3	0.0100	0.0100	0.0200	0.0220	0.0270	0.0240	0.0260	0.0300
>=0.6	>=0.006	>=6	0.0080	0.0080	0.0180	0.0190	0.0220	0.0220	0.0240	0.0280
<=0.1	<=0.0005	<=3	0.0120	0.0120	0.0275	0.0360	0.0280	0.0300	0.0360	0.0330
<=0.1	<=0.0005	>=6	0.0060	0.0060	0.0060	0.0080	0.0080	0.0070	0.0090	0.0090
>=0.6	<=0.0005	<=3	0.0040	0.0040	0.0040	0.0050	0.0050	0.0050	0.0070	0.0060
>=0.6	<=0.0005	>=6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000

ASCE 41-condition III		Existing parameters		Rectangular columns			Circular columns		
$P / A_g f_c'$	ρ''	a	b	a	b_P	b_R	a	b_P	b_R*
<=0.1	>=0.006	0.0000	0.0600	0.0000	0.0260	0.0770	0.0000	0.0250	0.0000
>=0.6	>=0.006	0.0000	0.0080	0.0000	0.0120	0.0180	0.0000	0.0130	0.0000
<=0.1	<=0.0005	0.0000	0.0060	0.0000	0.0009	0.0170	0.0000	0.0050	0.0000
>=0.6	<=0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000

Table 4.4: Final median estimates of modeling parameters

* No column data was available in the condition for this rotation measure.

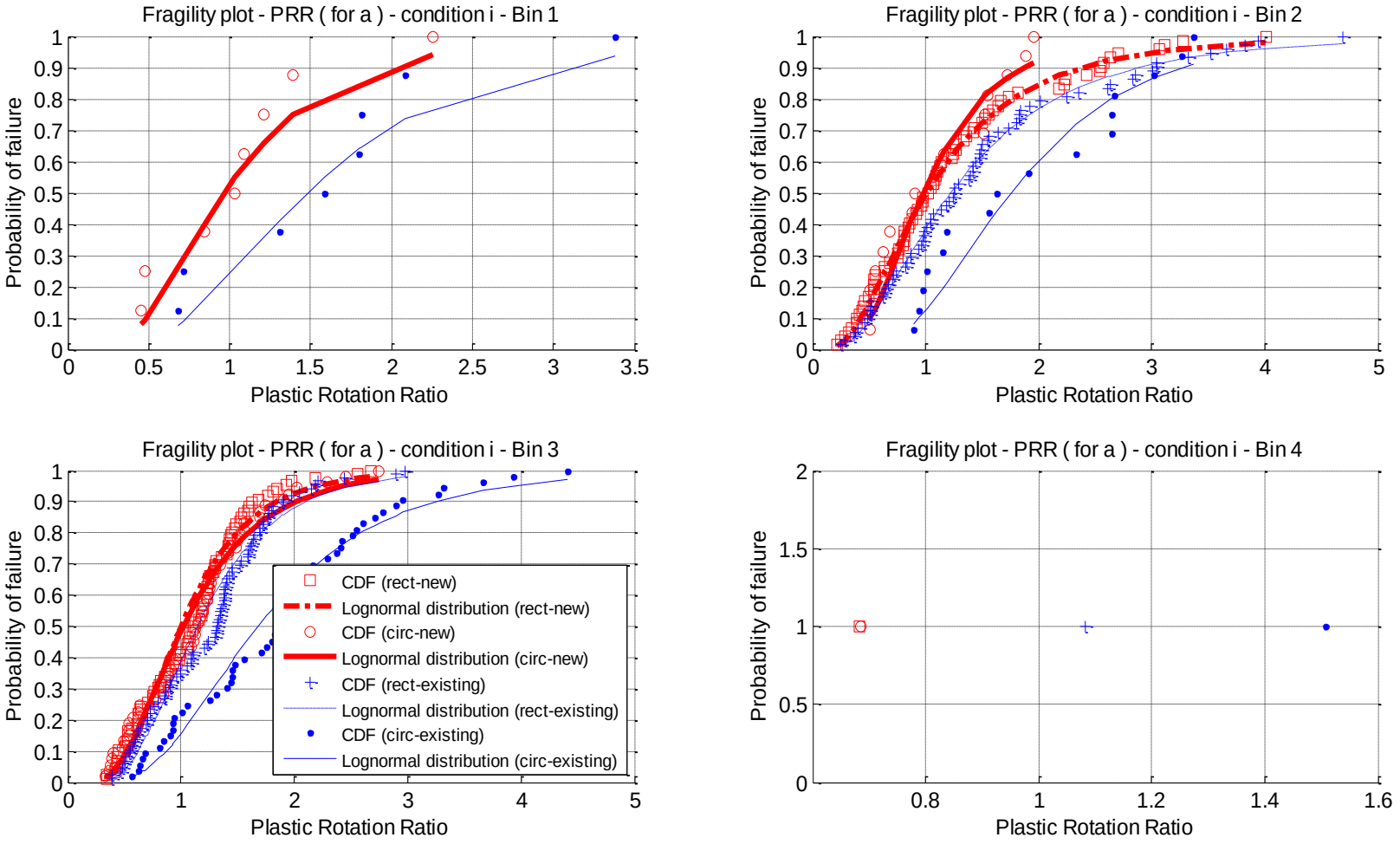


Figure 4.7: Fragility plots for PRR for plastic rotation, *a* – condition i

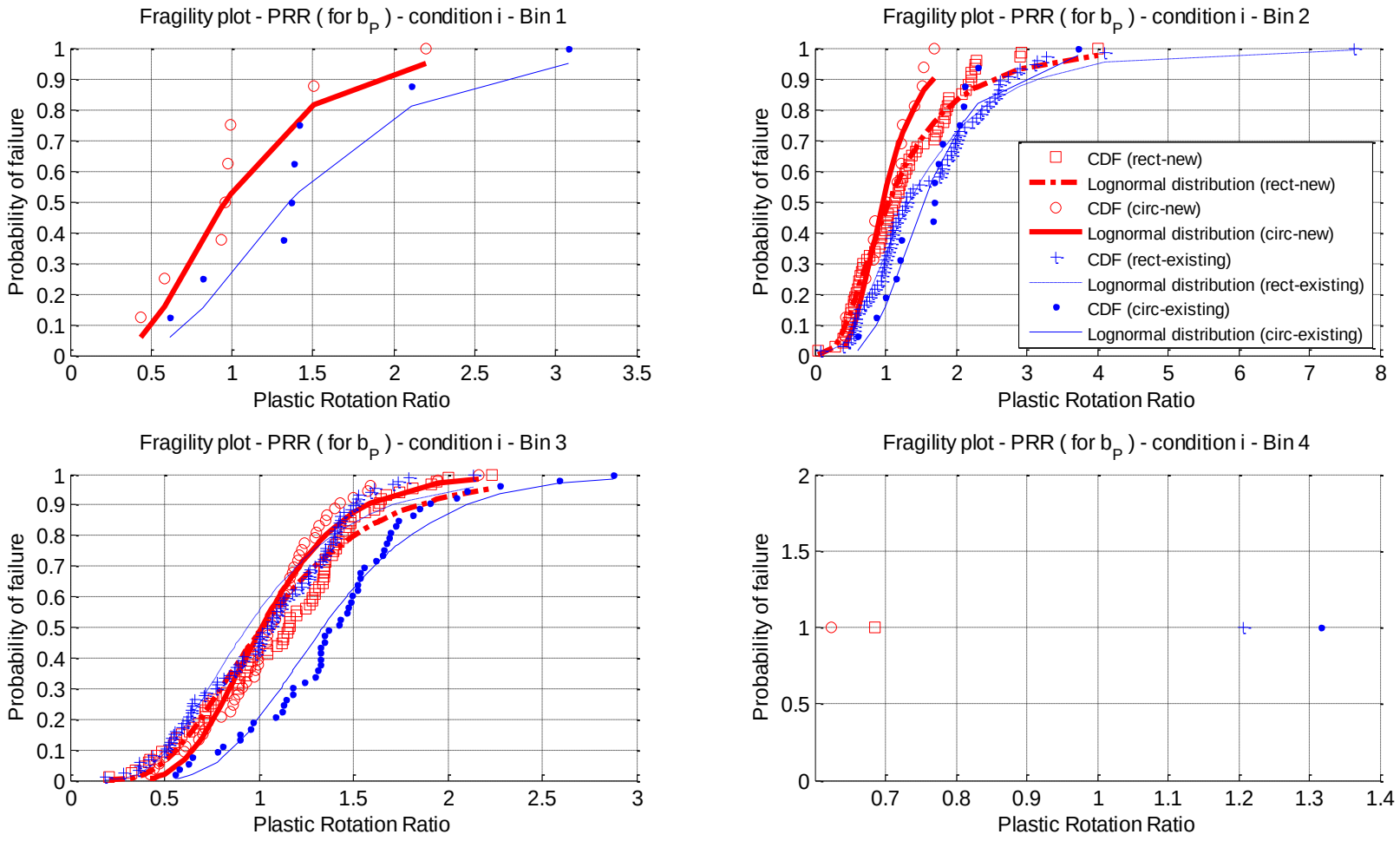


Figure 4.8: Fragility plots for PRR for plastic rotation, b_P – condition i

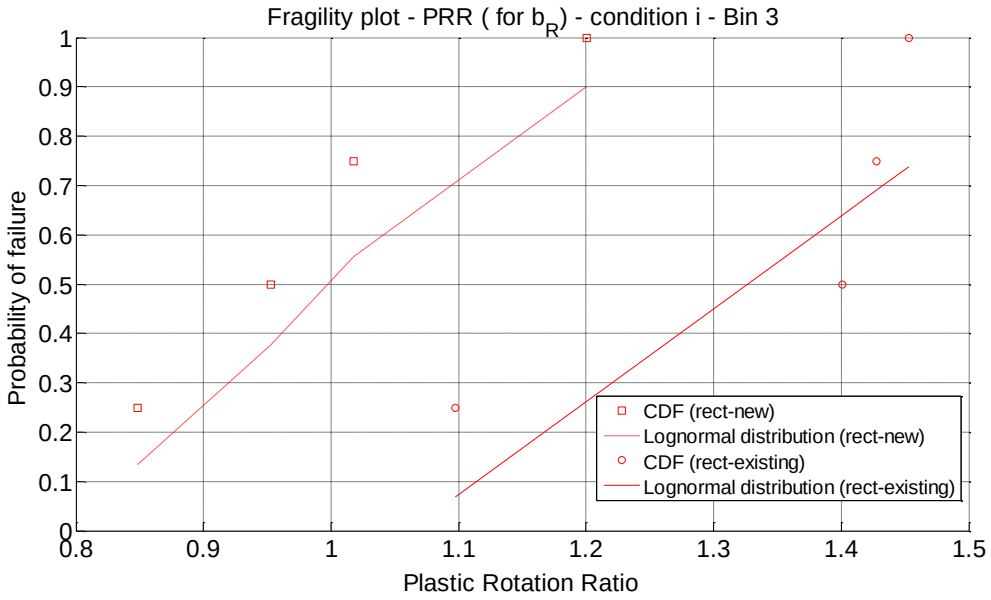


Figure 4.9: Fragility plots for PRR for plastic rotation, b_R – condition i

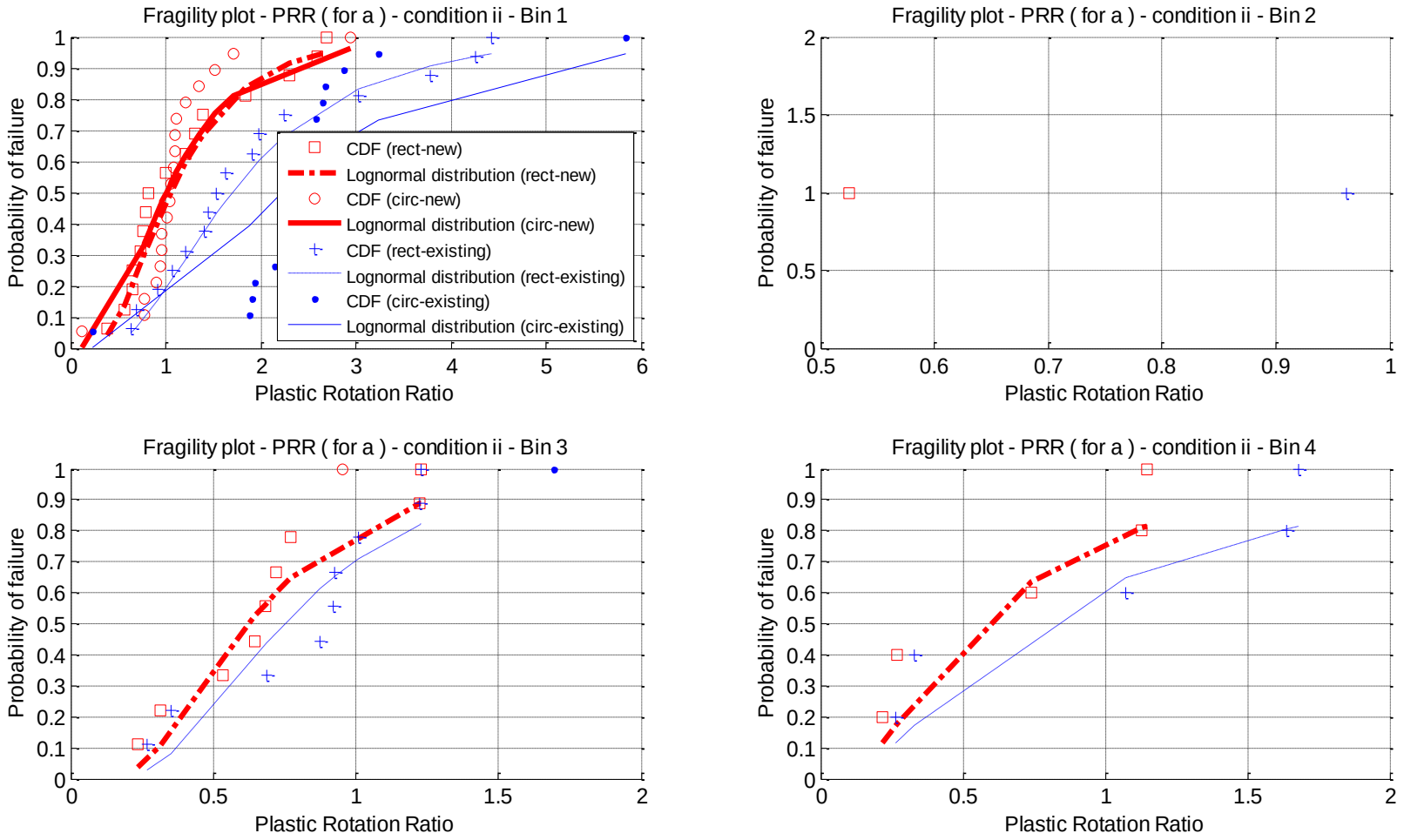


Figure 4.10.a: Fragility plots for PRR for plastic rotation, *a* – condition ii

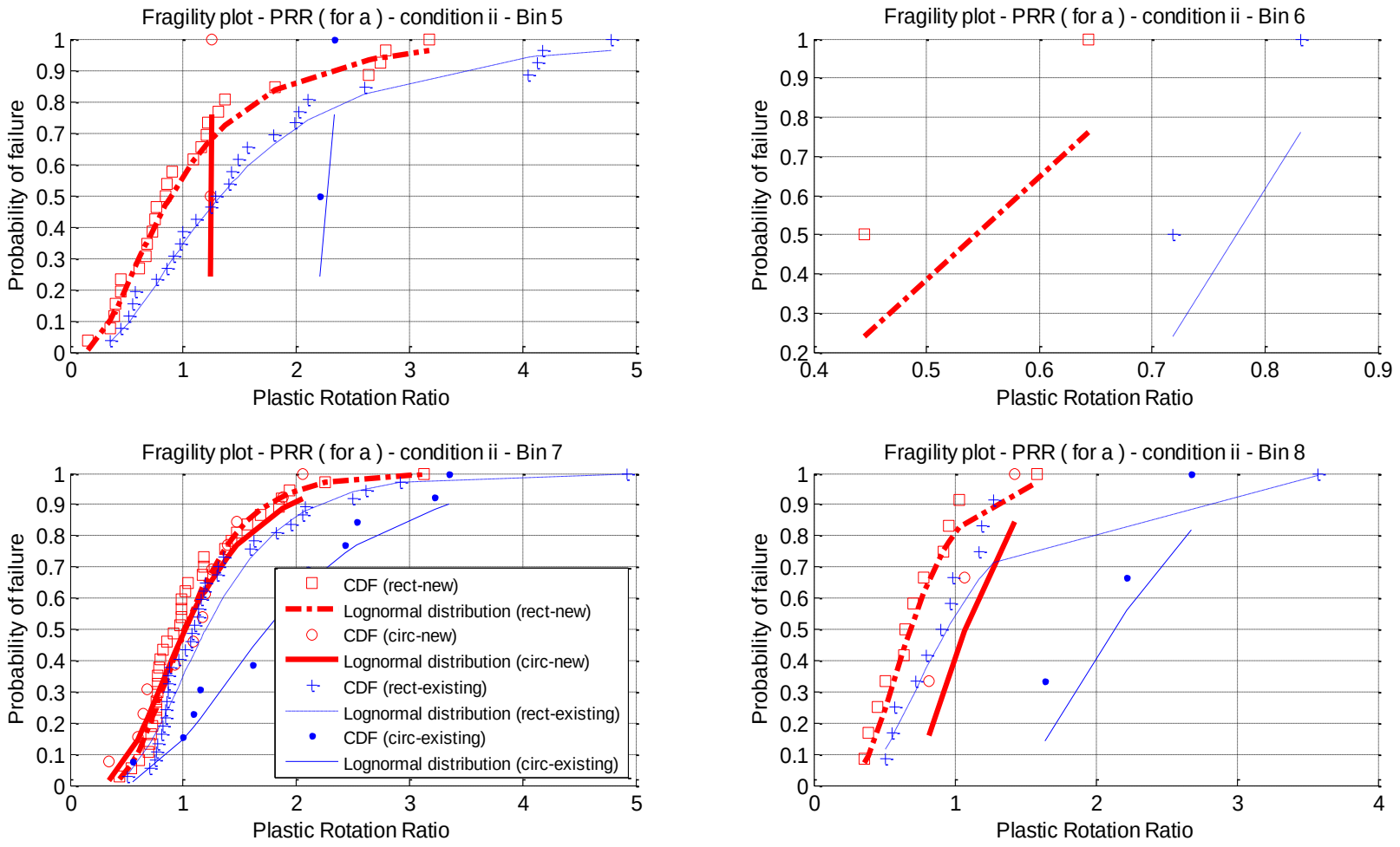


Figure 4.10.b: Fragility plots for PRR for plastic rotation, *a* – condition ii

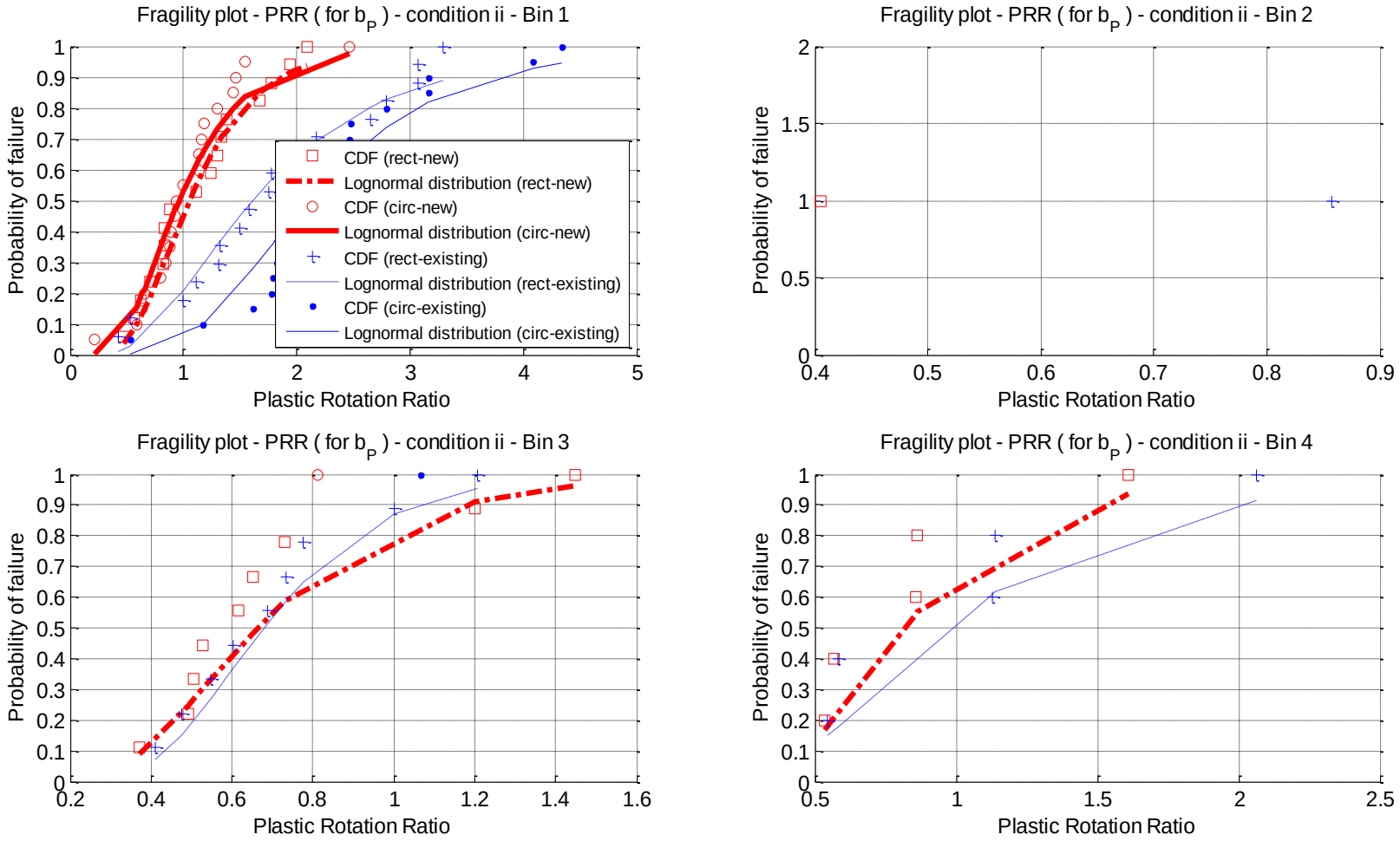


Figure 4.11.a: Fragility plots for PRR for plastic rotation, b_P – condition ii

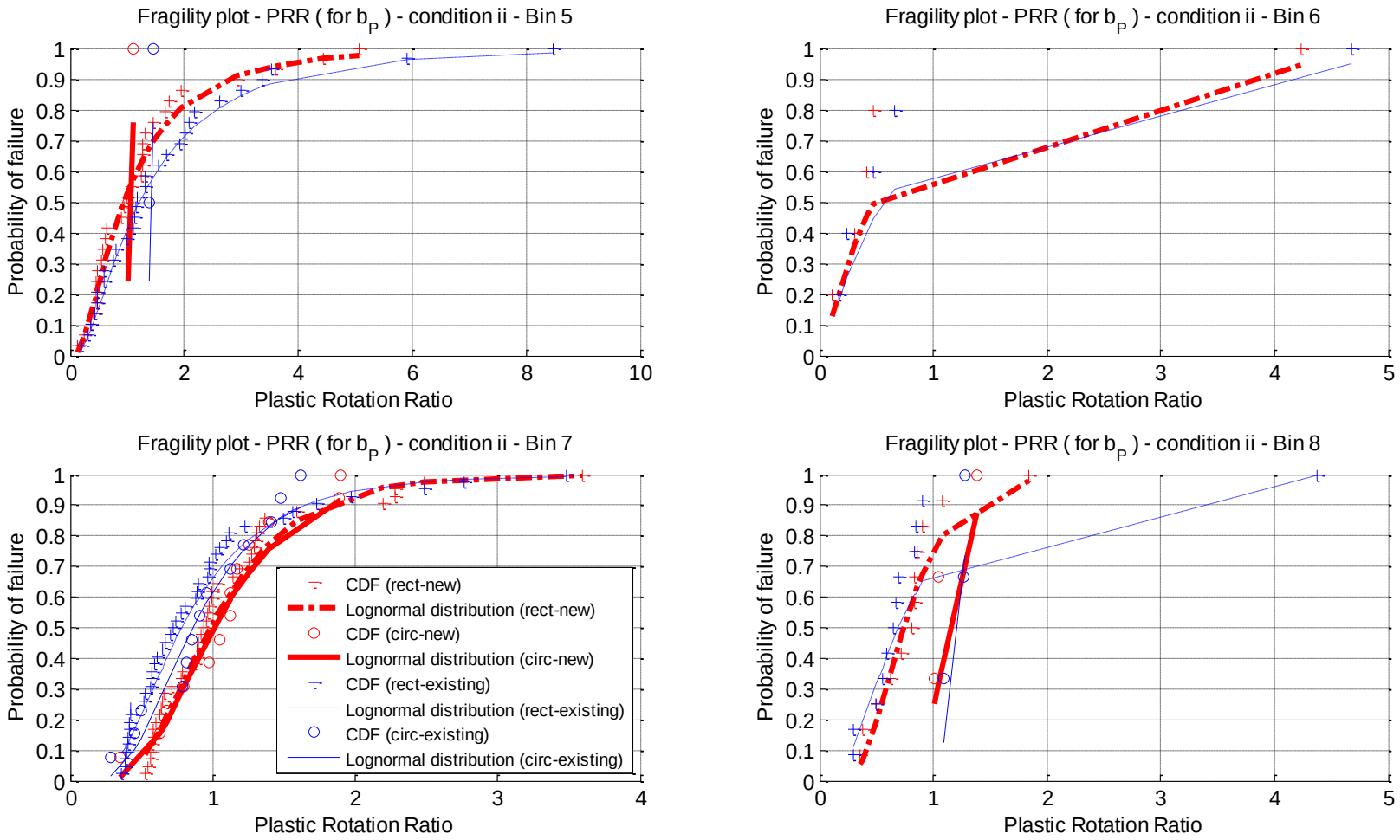


Figure 4.11.b: Fragility plots for PRR for plastic rotation, b_P – condition ii

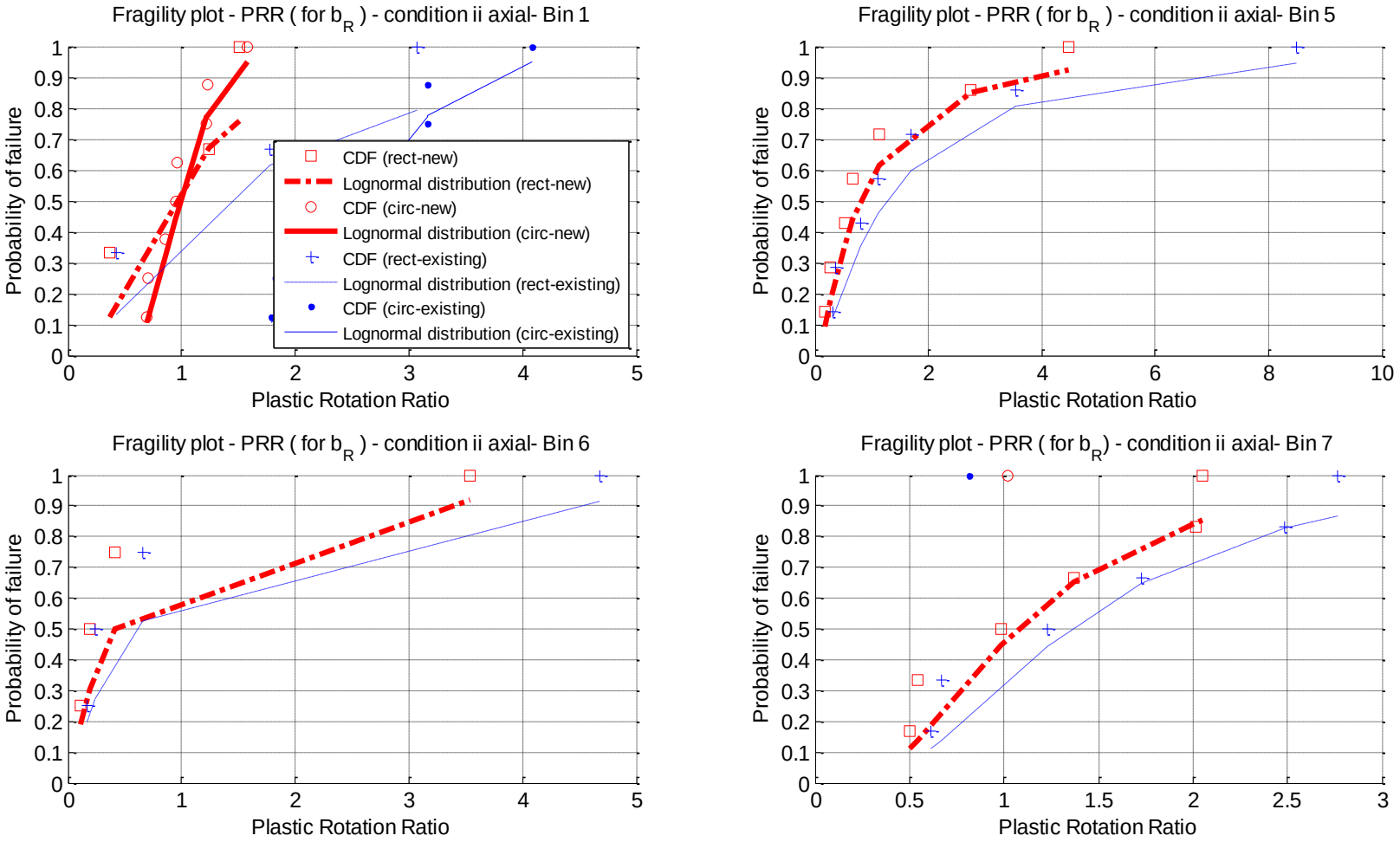


Figure 4.12: Fragility plots for PRR for plastic rotation, b_R – condition ii

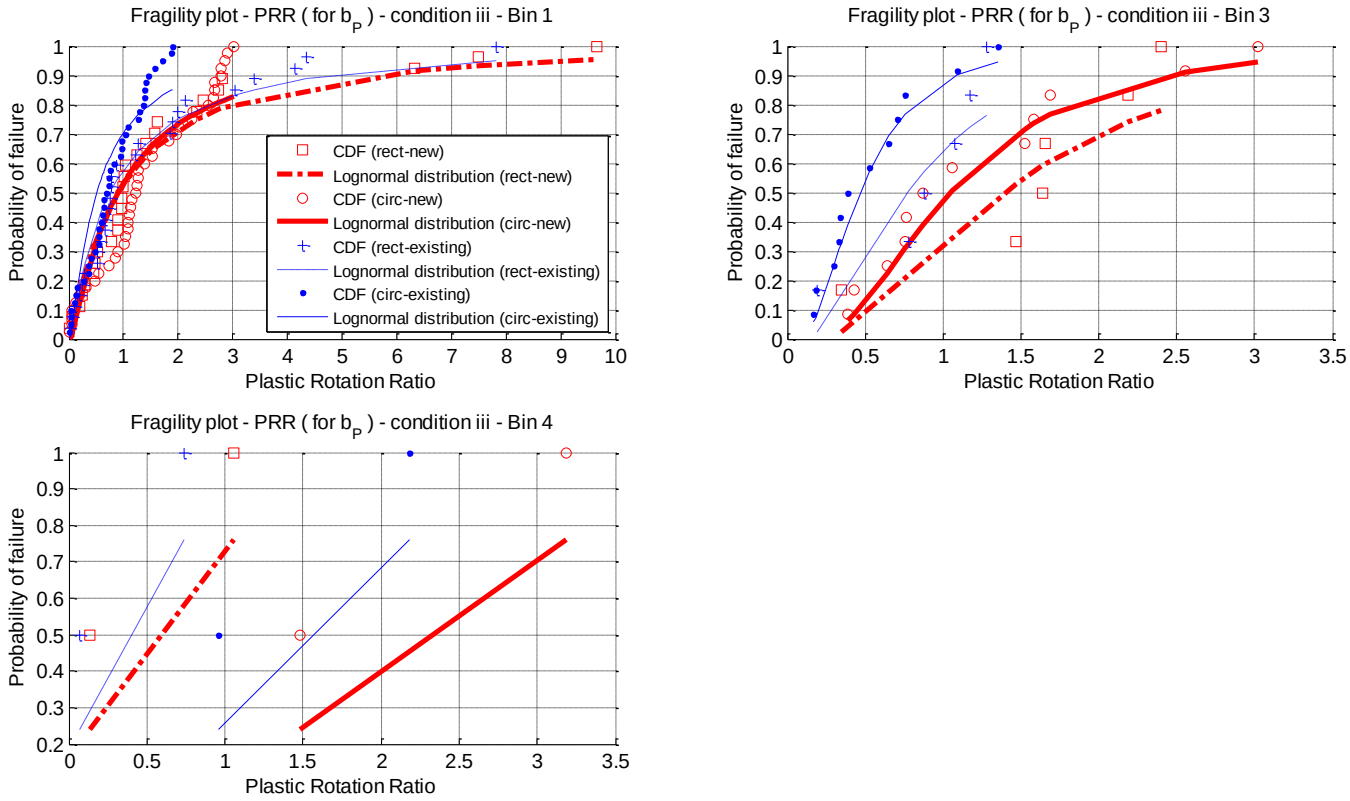


Figure 4.13: Fragility plots for PRR for plastic rotation, b_P – condition iii

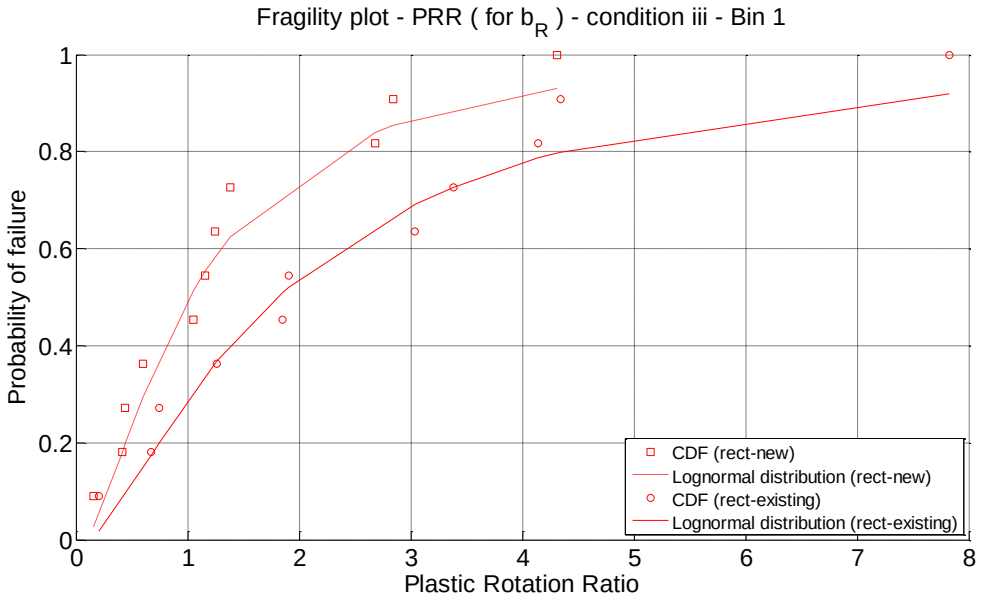


Figure 4.14: Fragility plots for PRR for plastic rotation, b_R – condition iii

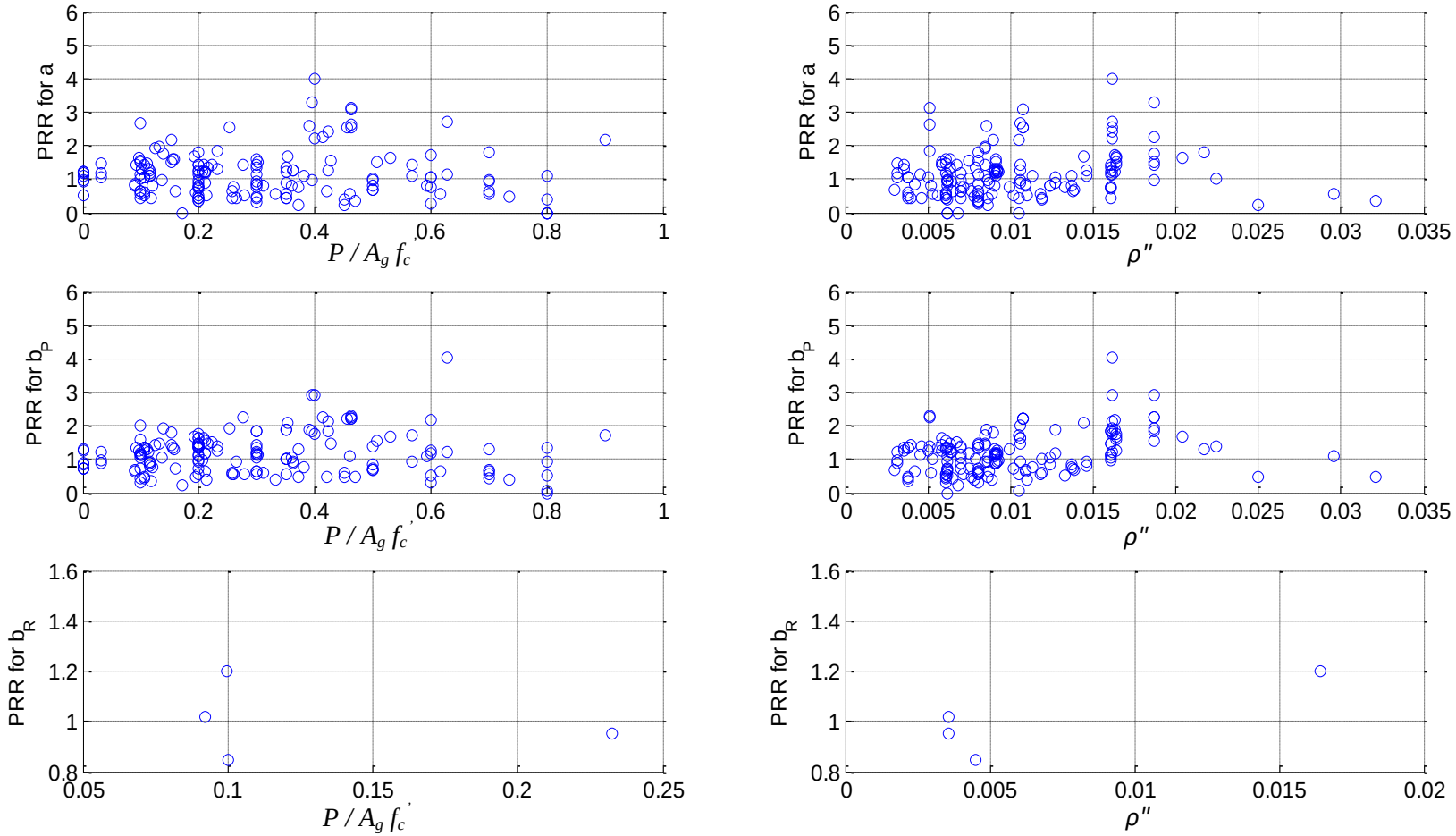


Figure 4.15: PRR vs regression parameters for condition i rectangular columns

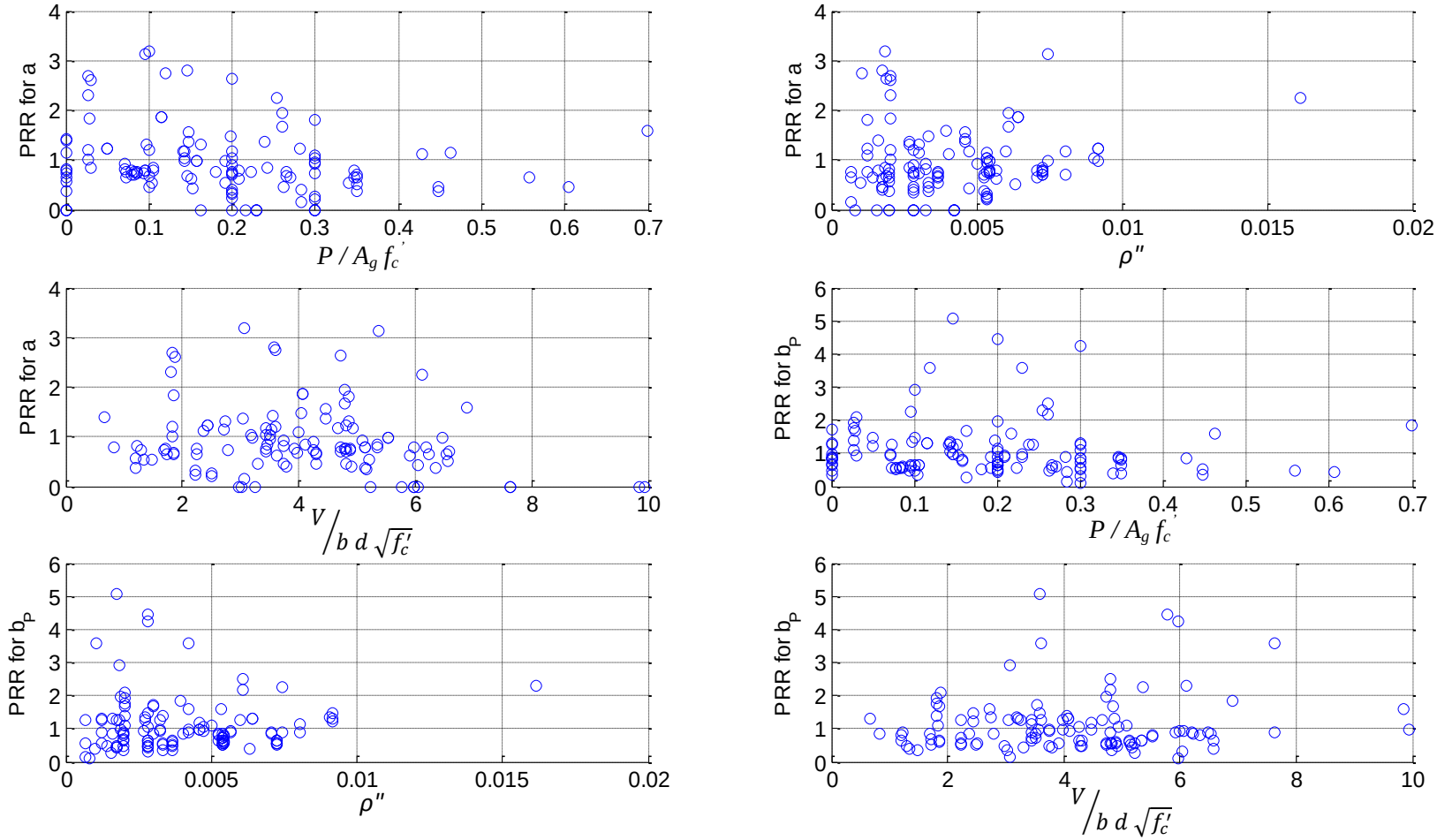


Figure 4.16.a: PRR vs regression parameters for condition ii rectangular columns

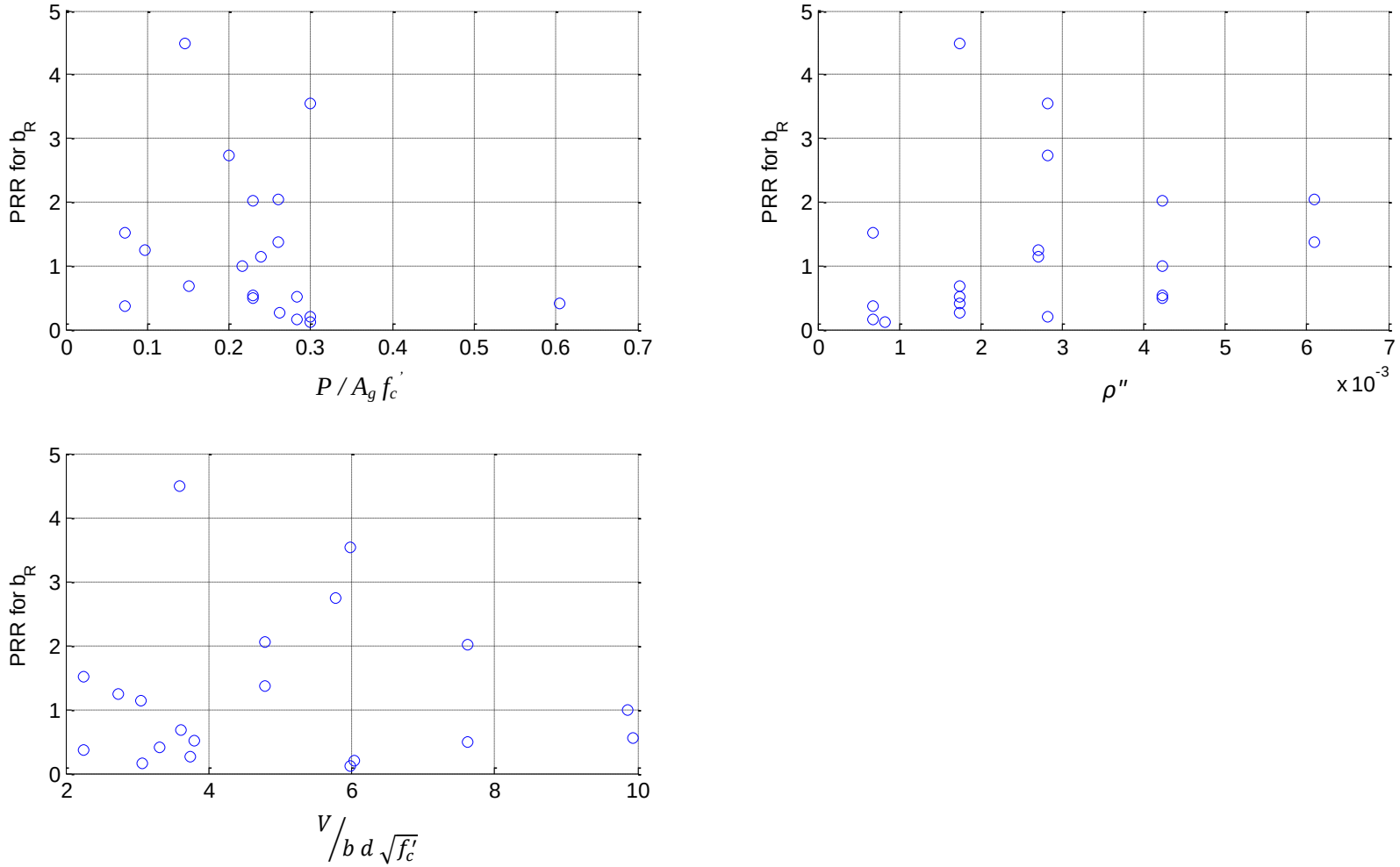


Figure 4.16.b: PRR vs regression parameters for condition ii rectangular columns

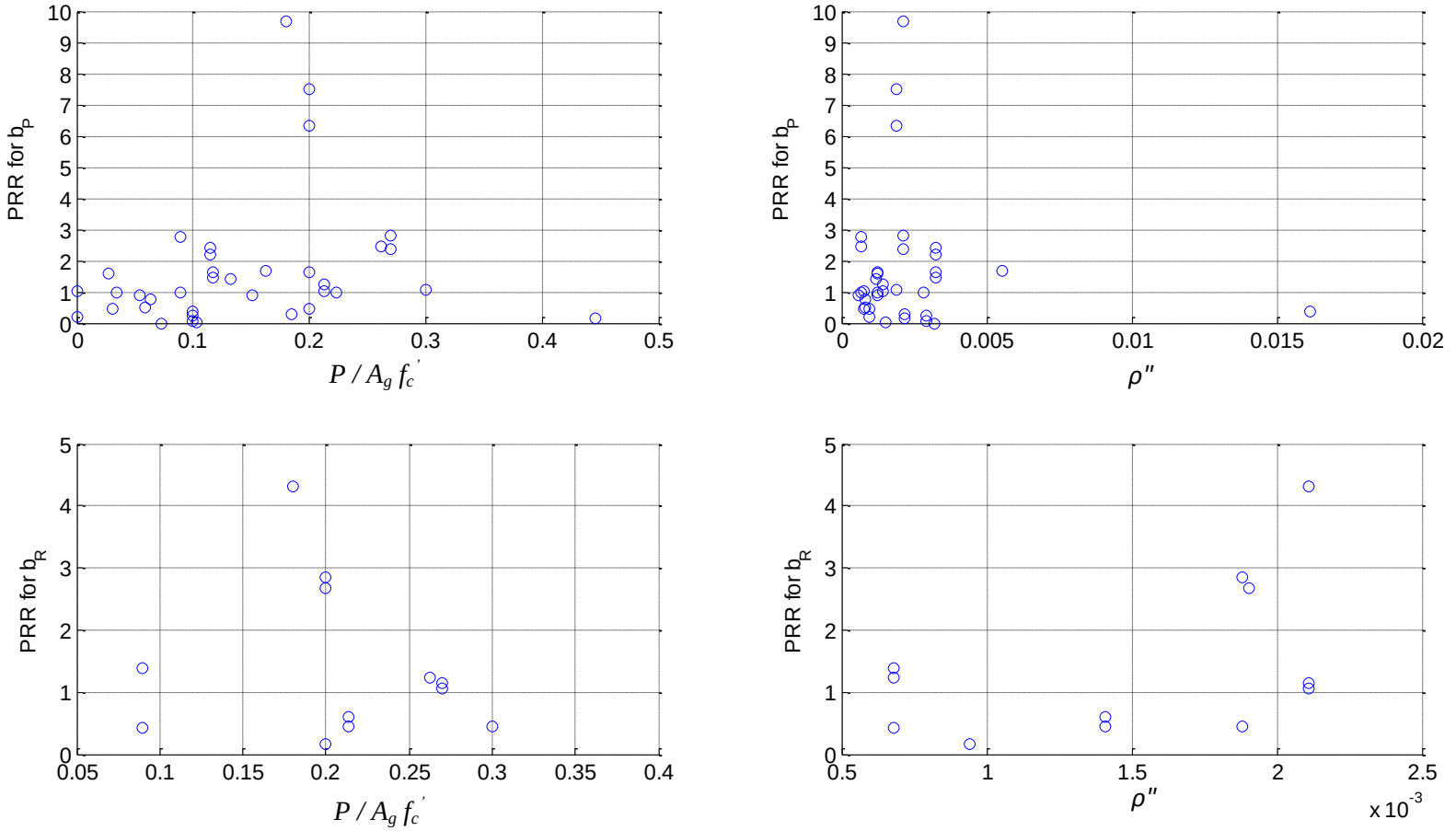


Figure 4.17: PRR vs regression parameters for condition iii rectangular columns

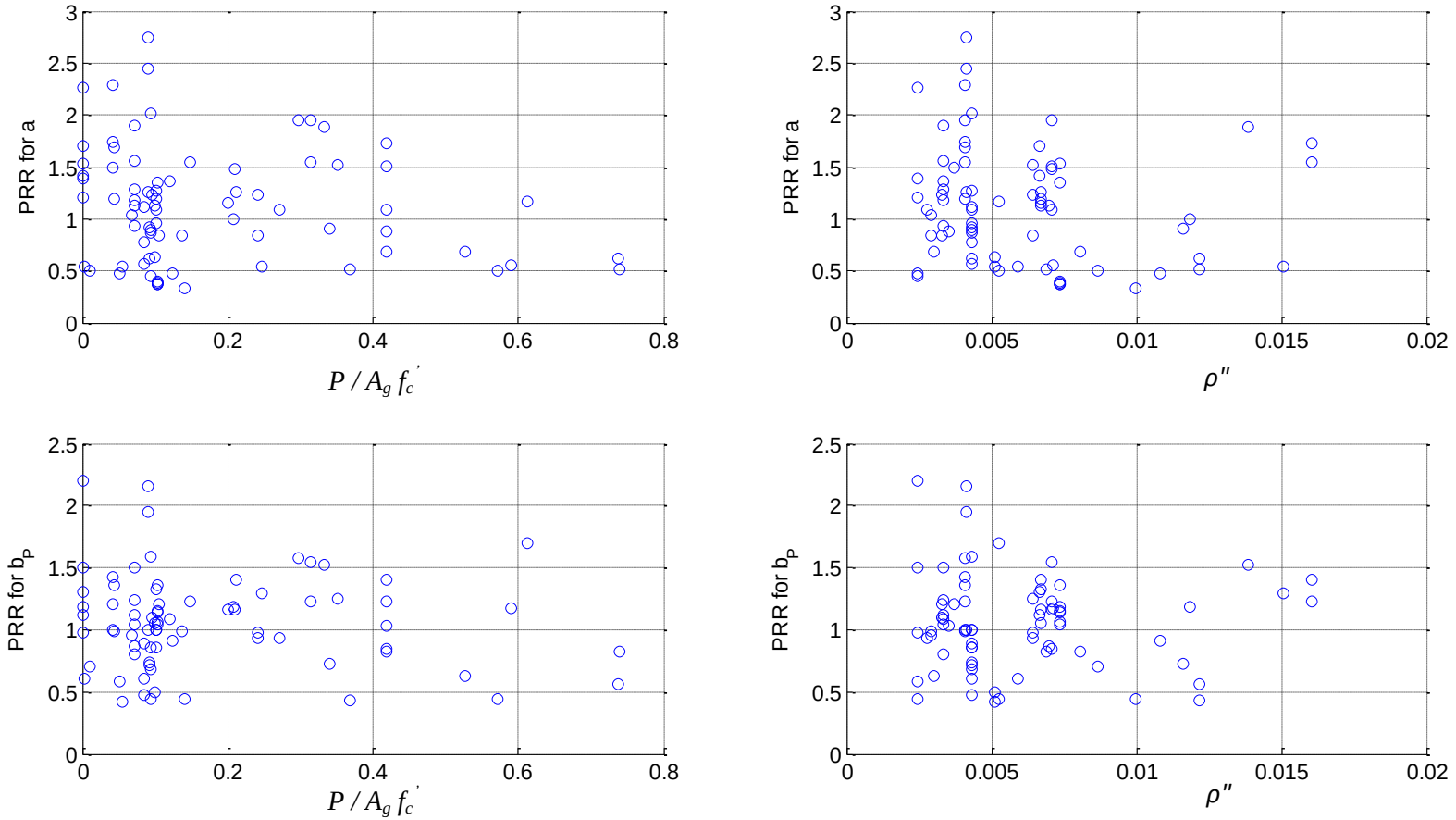


Figure 4.18: PRR vs regression parameters for condition i circular columns

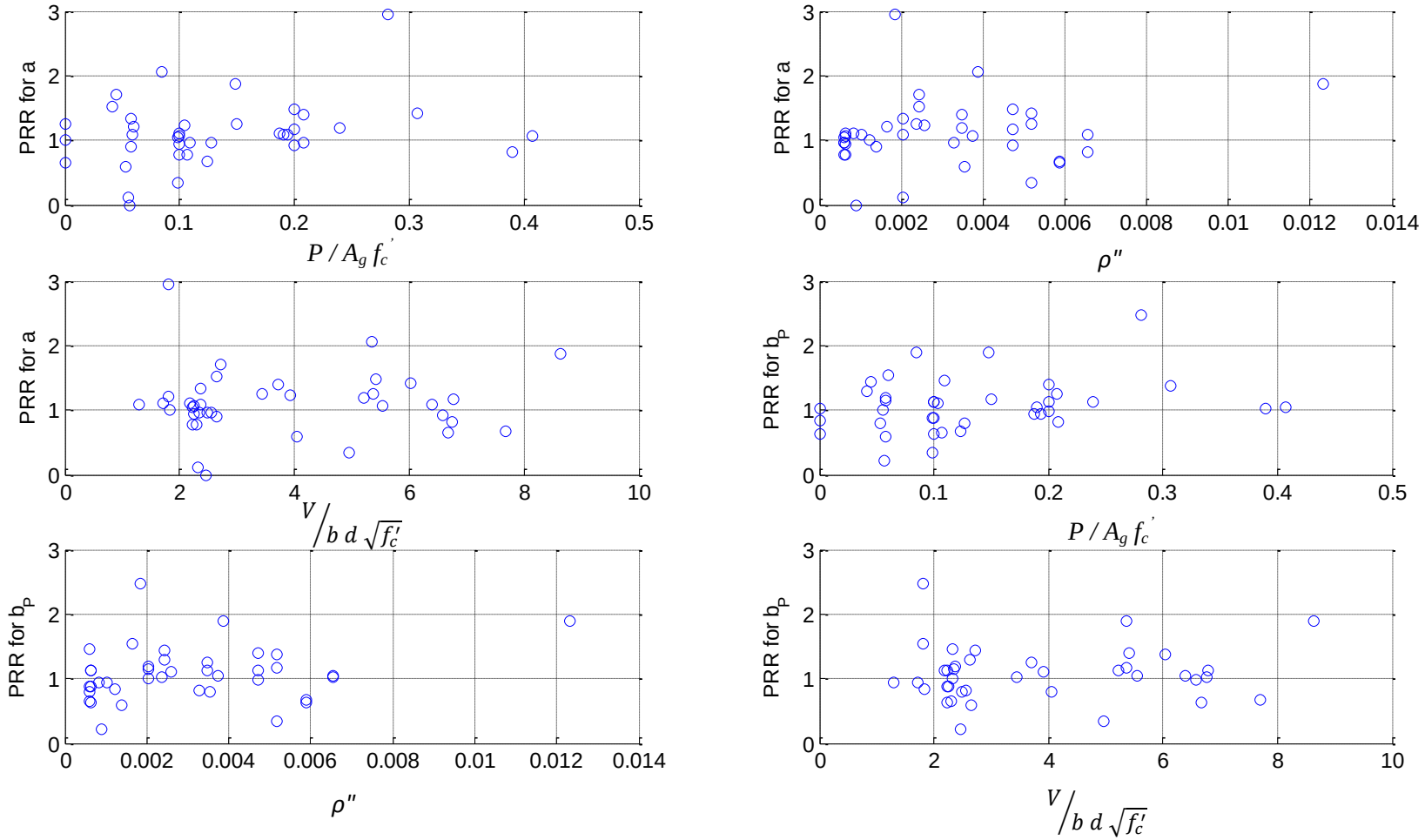
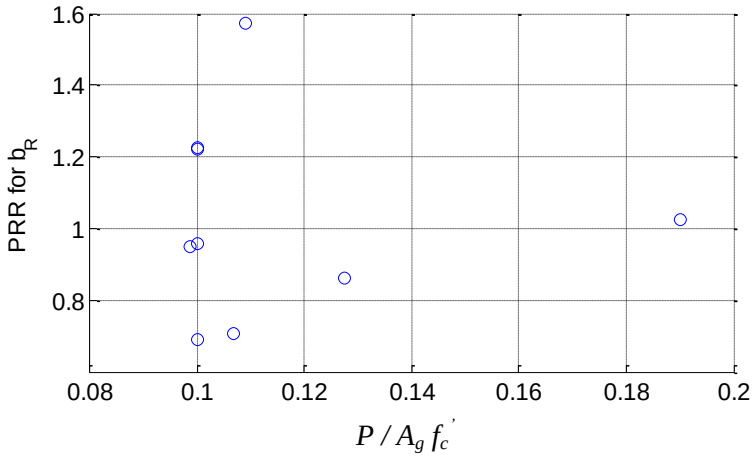
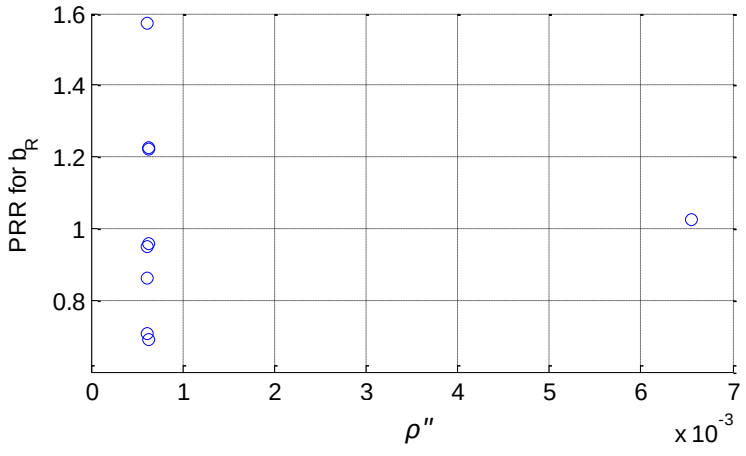


Figure 4.19.a: PRR vs regression parameters for condition ii circular columns





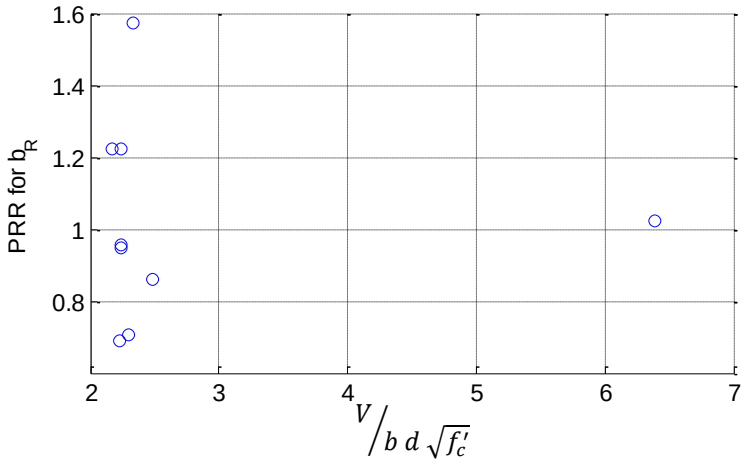


Figure 4.19.b: PRR vs regression parameters for condition ii circular columns

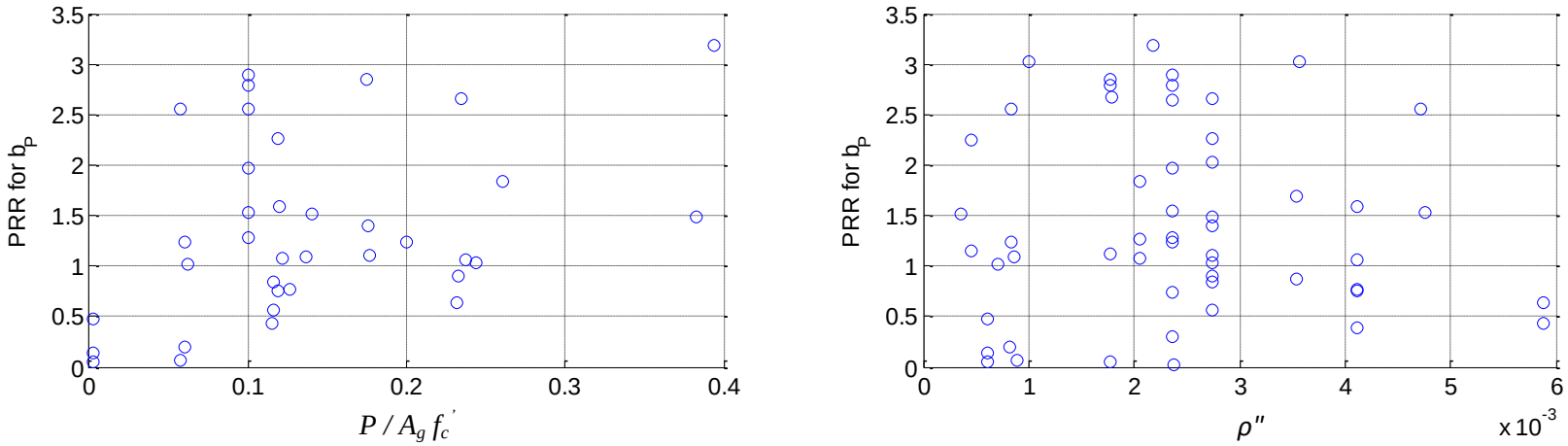


Figure 4.20: PRR vs regression parameters for condition iii circular columns

5. SUMMARY AND CONCLUSIONS

Seismic rehabilitation can be both costly and time consuming. For any structure, seismic rehabilitation is the product of seismic assessment that identifies critical deficiencies. Improving the accuracy of seismic assessment can result in optimized rehabilitation schemes that can reduce both cost and duration of rehabilitation.

Revisions to the non-linear procedures for reinforced concrete (RC) columns of ASCE 41-06 Supplement No. 1 are proposed in this study. Task to update ASCE-41-06 provisions pertaining to RC structures is now handled by ACI (American Concrete Institute) committee 369 entitled "Seismic Repair and Rehabilitation". This study is a part of ACI 369 committee's effort.

Currently, modeling parameters (MP) for various elements (e.g., columns, walls, joints, etc…) are derived with varying levels of conservatism. Such uneven conservatism across element MP can generate a prediction of an artificial failure mechanism in a structure that is quite different from the most likely mechanism. When simulating the behavior of a structure within the performance-based framework, it is best to get the best estimate of the response. Thus modeling parameters for RC columns were re-evaluated to represent the median of experimental data.

Although the scope of this project only encompassed MP of RC columns, it is the goal of this effort to apply such approach to revise MP for all RC elements treated by the ASCE 41-06. This would provide a uniform probability of exceedance for all the

structural elements, which should result in better estimation of performance of structures and more optimized rehabilitation efforts.

A database of 490 column tests was compiled for this project. Linear regression combined with adjustments that consider component fragility curves were used to select modeling parameters for RC columns. Current modeling parameters were derived using only rectangular column data. Circular columns were introduced in the database and new circular column modeling parameters produced. Consistent with current provisions, tables were developed for estimating MP values. Comparison between estimated and experimental parameters show that estimates based on proposed MP tables are less scattered compared to those based on current MP tables..

Future Work

Throughout this study, the focus was only on the MP. Acceptance criteria (AC) need to be modified to match revised modeling parameters. It was not the intent of this project to provide AC. Such task is left to ACI Committee 369 membership as significant judgment is necessary for selecting acceptable probabilities of failure for various failure modes, element types, and performance objective. This project provides all the necessary data for AC to be selected.

APPENDIX A-1 ELEMENTS OF COLUMN DATABASE

A.1.1 Column Data

Column data not defined in Chapter 2 and 3 are defined next.

A.1.1.1 Reported Data

a) *Scale factor* = ratio of size of test column to prototype column. If no scale factor was mentioned, it was assumed to be one.

b) *Depth (h)* = section height in the direction of loading. For circular columns, *h* was taken as section diameter.

c) *Effective cover (d')* = cover measured from the outer surface of the column to the center of closest longitudinal reinforcement.

d) *Length of column (L) = clear* distance between supports. *L* in the database refers to the actual full length of the specimen and not the equivalent single-cantilever column as was done in the PEER database.

Compressive Strength (f'_c)

Reported concrete compressive strength refers to 28-day compressive strength.

Longitudinal Reinforcement Details

a) *Size:* diameter of longitudinal bars is mentioned for all the columns (in inches).

b) *Layout:* the number of bars on the compression, tension, and side faces of the columns are mentioned separately. In this fashion, corner bars are counted multiple times. Bars were assumed to be evenly spaced on each face.

c) *Longitudinal Steel Material Properties:* yield stress (f_{yl}) and ultimate stress (f_{ul}) are presented for longitudinal bars. f_{yl} was obtained from source documents. If f_{ul} was not reported, it was estimated as 1.5 f_{yl}. In PEER database, f_{ul} was mentioned as zero for some columns and is reproduced in our database too.

d) For each circular column, angle (θ) between line of lateral load and radial line of bar closest to the line of lateral load is provided. This gives a picture of layout of longitudinal reinforcement with reference to direction of lateral loading. θ is calculated in degrees.

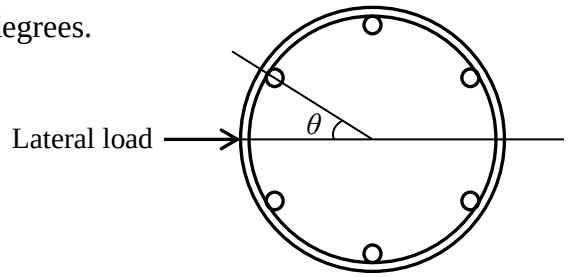


Figure A.1.1: Layout of longitudinal bars in circular columns

Transverse Reinforcement Details

a) *Size:* diameter of transverse tie or hoop is also presented.

b) *Layout:* the number of transverse bars parallel and perpendicular to load is presented. The spacing of transverse reinforcement (s) is also given.

c) *Transverse Steel Material Properties:* yield stress (f_{yt}) and ultimate stress (f_{ut}) are presented for transverse bars. f_{yt} was obtained from source documents. If f_{ut} was not reported, it was estimated as 1.5 f_{yt}. In PEER database, f_{ut} was mentioned as zero for some columns and is reproduced in our database too. Thirteen circular columns in the database have ties as transverse reinforcement. Eight of the 13 have ties that overlap, 1 of the 13 has ties with 135 degree hooks anchored into the column core and 1 has

ties with 90 degree hooks anchored into the core. Hook or lap details of ties for the other three columns were not available.

A.1.1.2 Calculated Data

a) *Elastic modulus of concrete,* $E_c = 57000\sqrt{f_c'}$ *(f_c' in psi units).* (As per 8.5.1 of ACI 318-08)

b) *Modulus of rupture of concrete was calculated for each column as,* $f_r = 7.5\sqrt{f_c'}$ *(f_c' in psi units).* (As per Eq. (9-10) of ACI 318-08)

c) *Volumetric transverse reinforcement ratio* (Vol. ρ_t) =

$$\frac{\text{volume of transverse reinforcement}}{\text{volume of concrete (measured out-to-out of transverse reinforcement)}}$$

A.1.1.3 Extracted Displacement Data

Displacements are mentioned in terms of drift ratio (δ) in %.

$$\delta_y = \frac{\Delta_y}{L} \text{ x } 100 \quad \text{(A.1.1)}$$

$$\delta_{vmax} = \frac{\Delta_{vmax}}{L} \text{ x } 100 \quad \text{(A.1.2)}$$

$$\delta_{0.8} = \frac{\Delta_{0.8}}{L} \text{ x } 100 \quad \text{(A.1.3)}$$

$$\delta_s = \frac{\Delta_S}{L} \text{ x } 100 \quad \text{(A.1.4)}$$

Values of all four types of lateral displacements corresponding to axial failure of columns are presented in the database. Displacement values are taken as zero if no column data was available.

$$\delta_{bb} = \frac{\Delta_{bp}}{L} \text{ x } 100 \quad \text{(A.1.5)}$$

APPENDIX A-2 REPORTED AND CALCULATED DATA OF DATABASE COLUMNS

Table A-2-1: Reported and calculated data of condition i rectangular columns

			Specimen dimensions							Axial load		Concrete properties		
Author	Column designation	Scale factor	h (in.)	b (in.)	d (in.)	d' (in.)	L (in.)	a (in.)	a/d	P (kips)	$\frac{P}{A_g f_c'}$	f_c' (psi)	E_c (psi)	f_r (psi)
Gill et al.	No.1	1	21.65	21.65	19.21	2.44	47.24	47.24	2.46	408.01	0.26	3349.50	3298867.31	434.06
Gill et al.	No.2	1	21.65	21.65	19.21	2.44	47.24	47.24	2.46	602.46	0.21	6003.00	4416304.68	581.09
Gill et al.	No.3	1	21.65	21.65	19.21	2.44	47.24	47.24	2.46	611.23	0.42	3103.00	3175160.94	417.78
Gill et al.	No.4	1	21.65	21.65	19.21	2.44	47.24	47.24	2.46	958.77	0.60	3407.50	3327306.34	437.80
Ang et al.	No.3	1	15.75	15.75	14.00	1.75	62.99	62.99	4.50	322.59	0.38	3422.00	3334378.20	438.73
Ang et al.	No.4	1	15.75	15.75	14.15	1.59	62.99	62.99	4.45	188.83	0.21	3625.00	3431854.45	451.56
Soesianawati et al.	No. 1	1	15.75	15.75	14.65	1.10	62.99	62.99	4.30	167.25	0.10	6742.50	4680425.46	615.85
Soesianawati et al.	No. 2	1	15.75	15.75	14.61	1.14	62.99	62.99	4.31	474.78	0.30	6380.00	4552869.42	599.06
Soesianawati et al.	No. 3	1	15.75	15.75	14.65	1.10	62.99	62.99	4.30	474.78	0.30	6380.00	4552869.42	599.06
Zahn	No.7	1	15.75	15.75	14.53	1.22	62.99	62.99	4.34	227.05	0.22	4103.50	3651338.32	480.44
Zahn	No.8	1	15.75	15.75	14.53	1.22	62.99	62.99	4.34	562.45	0.39	5814.50	4346413.52	571.90
Watson and Park	No.5	1	15.75	15.75	14.61	1.14	62.99	62.99	4.31	737.34	0.50	5945.00	4394918.09	578.28
Watson and Park	No.6	1	15.75	15.75	14.69	1.06	62.99	62.99	4.29	719.36	0.50	5800.00	4340990.67	571.18
Watson and Park	No.7	1	15.75	15.75	14.45	1.30	62.99	62.99	4.36	1057.46	0.70	6090.00	4448191.77	585.29
Watson and Park	No.8	1	15.75	15.75	14.61	1.14	62.99	62.99	4.31	981.93	0.70	5655.00	4286384.84	564.00
Watson and Park	No.9	1	15.75	15.75	14.45	1.30	62.99	62.99	4.36	1007.10	0.70	5800.00	4340990.67	571.18
Tanaka and Park	No1	1	15.75	15.75	13.31	2.44	62.99	62.99	4.73	184.11	0.20	3712.00	3472792.54	456.95
Tanaka and Park	No2	1	15.75	15.75	13.31	2.44	62.99	62.99	4.73	184.11	0.20	3712.00	3472792.54	456.95
Tanaka and Park	No3	1	15.75	15.75	13.31	2.44	62.99	62.99	4.73	184.11	0.20	3712.00	3472792.54	456.95
Tanaka and Park	No4	1	15.75	15.75	13.31	2.44	62.99	62.99	4.73	184.11	0.20	3712.00	3472792.54	456.95
Tanaka and Park	No5	1	21.65	21.65	19.21	2.44	64.96	64.96	3.38	217.61	0.10	4640.00	3882700.09	510.88
Tanaka and Park	No6	1	21.65	21.65	19.21	2.44	64.96	64.96	3.38	217.61	0.10	4640.00	3882700.09	510.88
Tanaka and Park	No7	1	21.65	21.65	19.21	2.44	64.96	64.96	3.38	654.84	0.30	4640.00	3882700.09	510.88
Tanaka and Park	No8	1	21.65	21.65	19.21	2.44	64.96	64.96	3.38	654.84	0.30	4654.50	3888762.08	511.68
Park and Paulay	No9	1	23.62	15.75	21.73	1.89	70.24	70.24	3.23	145.22	0.10	3900.50	3559877.03	468.40

Arakawa	No.102	1	9.84	9.84	8.34	1.50	29.53	14.76	1.77	96.44	0.33	2987.00	3115246.86	409.90
Ohno and Nishioka	L1	1	15.75	15.75	13.78	1.97	62.99	62.99	4.57	28.55	0.03	3596.00	3418099.47	449.75
Ohno and Nishioka	L2	1	15.75	15.75	13.78	1.97	62.99	62.99	4.57	28.55	0.03	3596.00	3418099.47	449.75
Ohno and Nishioka	L3	1	15.75	15.75	13.78	1.97	62.99	62.99	4.57	28.55	0.03	3596.00	3418099.47	449.75
Zhou	214-08	1	6.30	6.30	5.42	0.88	25.20	12.60	2.32	97.11	0.80	3059.50	3152826.59	414.85
Kanda et al.	85STC-1	1	9.84	9.84	8.88	0.96	59.06	29.53	3.32	41.34	0.11	4045.50	3625441.97	477.03
Kanda et al.	85STC-2	1	9.84	9.84	8.00	1.84	59.06	29.53	3.69	41.34	0.11	4045.50	3625441.97	477.03
Kanda et al.	85STC-3	1	9.84	9.84	8.00	1.84	59.06	29.53	3.69	41.34	0.11	4045.50	3625441.97	477.03
Kanda et al.	85PDC-1	1	9.84	9.84	8.00	1.84	59.06	29.53	3.69	41.36	0.12	3596.00	3418099.47	449.75
Kanda et al.	85PDC-2	1	9.84	9.84	8.00	1.84	59.06	29.53	3.69	41.36	0.11	4045.50	3625441.97	477.03
Kanda et al.	85PDC-3	1	9.84	9.84	8.00	1.84	59.06	29.53	3.69	41.36	0.11	4045.50	3625441.97	477.03
Mugurma et al.	AL-1	1	7.87	7.87	7.03	0.84	19.69	19.69	2.80	308.20	0.40	12426.50	6354030.10	836.06
Mugurma et al.	AH-1	1	7.87	7.87	7.03	0.84	19.69	19.69	2.80	308.20	0.40	12426.50	6354030.10	836.06
Mugurma et al.	AL-2	1	7.87	7.87	7.03	0.84	19.69	19.69	2.80	484.67	0.63	12426.50	6354030.10	836.06
Mugurma et al.	AH-2	1	7.87	7.87	7.03	0.84	19.69	19.69	2.80	484.67	0.63	12426.50	6354030.10	836.06
Mugurma et al.	BH-1	1	7.87	7.87	7.03	0.84	19.69	19.69	2.80	264.36	0.25	16791.00	7386065.19	971.85
Mugurma et al.	BL-2	1	7.87	7.87	7.03	0.84	19.69	19.69	2.80	440.38	0.42	16791.00	7386065.19	971.85
Mugurma et al.	BH-2	1	7.87	7.87	7.03	0.84	19.69	19.69	2.80	440.38	0.42	16791.00	7386065.19	971.85
Sakai et al.	B2	1	9.84	9.84	8.47	1.37	39.37	19.69	2.32	489.16	0.35	14427.50	6846528.13	900.86
Sakai et al.	B4	1	9.84	9.84	8.47	1.37	39.37	19.69	2.32	489.16	0.35	14427.50	6846528.13	900.86
Sakai et al.	B5	1	9.84	9.84	8.47	1.37	39.37	19.69	2.32	489.16	0.35	14427.50	6846528.13	900.86
Atalay and Penzein	No.1S1	1	12.01	12.01	9.94	2.07	65.98	65.98	6.64	60.02	0.10	4219.50	3702587.68	487.18
Atalay and Penzein	No.3S1	1	12.01	12.01	9.94	2.07	65.98	65.98	6.64	60.02	0.10	4234.00	3708944.05	488.02
Atalay and Penzein	No.5S1	1	12.01	12.01	9.94	2.07	65.98	65.98	6.64	120.04	0.20	4263.00	3721624.24	489.69
Atalay and Penzein	No.9	1	12.01	12.01	9.94	2.07	65.98	65.98	6.64	180.06	0.26	4828.50	3960782.31	521.16
Atalay and Penzein	No.11	1	12.01	12.01	9.94	2.07	65.98	65.98	6.64	180.06	0.28	4495.00	3821551.39	502.84
Azizinamini et al.	NC 2	1	17.99	17.99	15.49	2.50	54.02	54.02	3.49	379.91	0.21	5698.50	4302839.35	566.16
Azizinamini et al.	NC 4	1	17.99	17.99	15.49	2.50	54.02	54.02	3.49	579.98	0.31	5771.00	4330124.59	569.75
Saatcioglu and Ozcebe	U4	1	13.78	13.78	12.00	1.78	39.37	39.37	3.28	134.88	0.15	4640.00	3882700.09	510.88
Saatcioglu and Ozcebe	U6	1	13.78	13.78	12.00	1.78	39.37	39.37	3.28	134.88	0.13	5408.50	4191922.77	551.57

Saatcioglu and Ozcebe	U7	1	13.78	13.78	12.00	1.78	39.37	39.37	3.28	134.88	0.13	5655.00	4286384.84	564.00
Galeota et al.	BA1	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	BA2	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	337.20	0.30	11600.00	6139087.88	807.77
Galeota et al.	BA3	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	337.20	0.30	11600.00	6139087.88	807.77
Galeota et al.	BA4	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	CA1	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	CA2	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	337.20	0.30	11600.00	6139087.88	807.77
Galeota et al.	CA3	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	CA4	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	337.20	0.30	11600.00	6139087.88	807.77
Galeota et al.	BB4	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	337.20	0.30	11600.00	6139087.88	807.77
Galeota et al.	BB4B	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	337.20	0.30	11600.00	6139087.88	807.77
Galeota et al.	CB1	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	CB2	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	CB3	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	337.20	0.30	11600.00	6139087.88	807.77
Galeota et al.	CB4	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	337.20	0.30	11600.00	6139087.88	807.77
Wehbe et al.	B1	1	24.02	14.96	22.42	1.60	91.93	91.93	4.10	135.10	0.09	4074.50	3638413.18	478.74
Wehbe et al.	B2	1	24.02	14.96	22.42	1.60	91.93	91.93	4.10	340.35	0.23	4074.50	3638413.18	478.74
Xiao and Martirossyan	HC4-8L19-T10-0.1P	1	10.00	10.00	8.74	1.26	40.00	20.00	2.29	109.93	0.10	11020.00	5983642.70	787.32
Xiao and Martirossyan	HC4-8L19-T10-0.2P	1	10.00	10.00	8.74	1.26	40.00	20.00	2.29	220.08	0.20	11020.00	5983642.70	787.32
Xiao and Martirossyan	HC4-8L16-T10-0.1P	1	10.00	10.00	8.80	1.20	40.00	20.00	2.27	120.04	0.10	12470.00	6365141.79	837.52
Xiao and Martirossyan	HC4-8L16-T10-0.2P	1	10.00	10.00	8.80	1.20	40.00	20.00	2.27	240.09	0.19	12470.00	6365141.79	837.52
Sugano	UC10H	1	8.86	8.86	8.02	0.84	35.43	17.72	2.21	804.56	0.60	17110.00	7455896.32	981.04
Sugano	UC15H	1	8.86	8.86	7.97	0.89	35.43	17.72	2.22	804.56	0.60	17110.00	7455896.32	981.04
Sugano	UC20H	1	8.86	8.86	7.97	0.89	35.43	17.72	2.22	804.56	0.60	17110.00	7455896.32	981.04
Sugano	UC15L	1	8.86	8.86	7.97	0.89	35.43	17.72	2.22	469.61	0.35	17110.00	7455896.32	981.04
Sugano	UC20L	1	8.86	8.86	7.97	0.89	35.43	17.72	2.22	469.61	0.35	17110.00	7455896.32	981.04
Bayrak and Sheikh	ES-1HT	1	12.01	12.01	10.54	1.47	72.52	72.52	6.88	753.88	0.50	10454.50	5828093.21	766.85
Bayrak and Sheikh	AS-2HT	1	12.01	12.01	10.63	1.38	72.52	72.52	6.82	539.78	0.36	10396.50	5811904.03	764.72
Bayrak and Sheikh	AS-3HT	1	12.01	12.01	10.63	1.38	72.52	72.52	6.82	750.74	0.50	10411.00	5815955.55	765.26

Bayrak and Sheikh	AS-4HT	1	12.01	12.01	10.54	1.47	72.52	72.52	6.88	751.79	0.50	10425.50	5820004.25	765.79
Bayrak and Sheikh	AS-5HT	1	12.01	12.01	10.54	1.47	72.52	72.52	6.88	957.87	0.45	14761.00	6925206.78	911.21
Bayrak and Sheikh	AS-6HT	1	12.01	12.01	10.54	1.47	72.52	72.52	6.88	980.23	0.46	14775.50	6928607.33	911.66
Bayrak and Sheikh	AS-7HT	1	12.01	12.01	10.63	1.38	72.52	72.52	6.82	959.86	0.45	14790.00	6932006.20	912.11
Bayrak and Sheikh	ES-8HT	1	12.01	12.01	10.54	1.47	72.52	72.52	6.88	1004.49	0.47	14819.00	6938798.96	913.00
Saatcioglu and Giria	BG-2	1	13.78	13.78	11.88	1.90	64.76	64.76	5.45	400.59	0.43	4930.00	4002195.65	526.60
Saatcioglu and Giria	BG-3	1	13.78	13.78	11.88	1.90	64.76	64.76	5.45	186.81	0.20	4930.00	4002195.65	526.60
Saatcioglu and Giria	BG-5	1	13.78	13.78	11.88	1.90	64.76	64.76	5.45	432.29	0.46	4930.00	4002195.65	526.60
Saatcioglu and Giria	BG-6	1	13.78	13.78	11.67	2.11	64.76	64.76	5.55	427.12	0.46	4930.00	4002195.65	526.60
Saatcioglu and Giria	BG-7	1	13.78	13.78	11.99	1.79	64.76	64.76	5.40	432.29	0.46	4930.00	4002195.65	526.60
Saatcioglu and Giria	BG-8	1	13.78	13.78	11.99	1.79	64.76	64.76	5.40	216.03	0.23	4930.00	4002195.65	526.60
Saatcioglu and Giria	BG-9	1	13.78	13.78	12.06	1.72	64.76	64.76	5.37	432.29	0.46	4930.00	4002195.65	526.60
Saatcioglu and Giria	BG-10	1	13.78	13.78	11.95	1.83	64.76	64.76	5.42	432.29	0.46	4930.00	4002195.65	526.60
Matamoros et al.	C10-10N	1	7.99	7.99	6.29	1.70	24.02	24.02	3.82	64.07	0.10	9827.44	5650606.93	743.50
Matamoros et al.	C10-10S	1	7.99	7.99	6.37	1.62	24.02	24.02	3.77	64.07	0.10	9827.44	5650606.93	743.50
Matamoros et al.	C10-20N	1	7.99	7.99	6.44	1.55	24.02	24.02	3.73	127.91	0.21	9497.53	5554949.84	730.91
Matamoros et al.	C10-20S	1	7.99	7.99	6.73	1.26	24.02	24.02	3.57	127.91	0.21	9497.53	5554949.84	730.91
Matamoros et al.	C5-00N	1	7.99	7.99	6.36	1.63	24.02	24.02	3.78	0.00	0.00	5498.57	4226683.06	556.14
Matamoros et al.	C5-00S	1	7.99	7.99	6.21	1.78	24.02	24.02	3.87	0.00	0.00	5498.57	4226683.06	556.14
Matamoros et al.	C5-40N	1	7.99	7.99	6.49	1.50	24.02	24.02	3.70	127.91	0.36	5518.56	4234360.97	557.15
Matamoros et al.	C5-40S	1	7.99	7.99	6.49	1.50	24.02	24.02	3.70	127.91	0.36	5518.56	4234360.97	557.15
Mo and Wang	C1-1	1	15.75	15.75	13.78	1.96	55.12	55.12	4.00	101.16	0.11	3616.30	3427733.76	451.02
Mo and Wang	C1-2	1	15.75	15.75	13.78	1.96	55.12	55.12	4.00	151.74	0.16	3867.15	3544625.56	466.40
Mo and Wang	C1-3	1	15.75	15.75	13.78	1.96	55.12	55.12	4.00	202.32	0.22	3788.85	3508557.20	461.65
Mo and Wang	C2-1	1	15.75	15.75	13.78	1.96	55.12	55.12	4.00	101.16	0.11	3672.85	3454430.44	454.53
Mo and Wang	C2-2	1	15.75	15.75	13.78	1.96	55.12	55.12	4.00	151.74	0.16	3932.40	3574404.51	470.32
Mo and Wang	C2-3	1	15.75	15.75	13.78	1.96	55.12	55.12	4.00	202.32	0.21	3881.65	3551264.68	467.27

Mo and Wang	C3-1	1	15.75	15.75	13.78	1.96	55.12	55.12	4.00	101.16	0.11	3828.00	3526637.49	464.03
Mo and Wang	C3-2	1	15.75	15.75	13.78	1.96	55.12	55.12	4.00	151.74	0.15	3987.50	3599359.32	473.60
Mo and Wang	C3-3	1	15.75	15.75	13.78	1.96	55.12	55.12	4.00	202.32	0.21	3900.50	3559877.03	468.40
Aboutaha and Machado	ORC1	1	20.00	12.01	18.50	1.50	72.01	72.01	3.89	0.00	0.00	12035.00	6253136.41	822.78
Aboutaha and Machado	ORC2	1	20.00	12.01	18.50	1.50	72.01	72.01	3.89	346.87	0.12	12035.00	6253136.41	822.78
Aboutaha and Machado	ORC3	1	20.00	12.01	18.50	1.50	72.01	72.01	3.89	462.64	0.16	12035.00	6253136.41	822.78
Thomsen and Wallace	A1	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	0.00	0.00	14891.50	6955751.83	915.23
Thomsen and Wallace	A3	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	90.12	0.20	12513.50	6376234.12	838.98
Thomsen and Wallace	B1	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	0.00	0.00	12687.50	6420411.79	844.79
Thomsen and Wallace	B2	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	43.54	0.10	12093.00	6268186.10	824.76
Thomsen and Wallace	B3	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	93.98	0.20	13050.00	6511486.01	856.77
Thomsen and Wallace	C1	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	0.00	0.00	9787.50	5639112.30	741.99
Thomsen and Wallace	C2	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	38.95	0.10	10817.00	5928274.03	780.04
Thomsen and Wallace	C3	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	85.42	0.20	11861.00	6207768.44	816.81
Thomsen and Wallace	D1	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	79.15	0.20	10991.00	5975764.30	786.28
Thomsen and Wallace	D2	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	90.85	0.20	12615.00	6402041.47	842.37
Thomsen and Wallace	D3	1	6.00	6.00	5.25	0.75	23.50	23.50	4.48	74.35	0.20	10324.00	5791603.92	762.05
Paultre & Legeron	1006015	1	12.01	12.01	10.50	1.51	78.74	78.74	7.50	269.76	0.14	13398.00	6597734.61	868.12
Paultre & Legeron	1006025	1	12.01	12.01	10.50	1.51	78.74	78.74	7.50	539.52	0.28	13528.50	6629788.57	872.34
Paultre & Legeron	1006040	1	12.01	12.01	10.50	1.51	78.74	78.74	7.50	809.28	0.39	14239.00	6801655.02	894.95
Paultre & Legeron	10013015	1	12.01	12.01	10.50	1.51	78.74	78.74	7.50	269.76	0.14	13746.00	6682870.19	879.33
Paultre & Legeron	10013025	1	12.01	12.01	10.50	1.51	78.74	78.74	7.50	539.52	0.26	14166.50	6784317.10	892.67
Paultre & Legeron	10013040	1	12.01	12.01	10.50	1.51	78.74	78.74	7.50	809.28	0.37	15123.50	7009725.49	922.33

Paultre et al.	806040	1	12.01	12.01	10.50	1.51	78.74	78.74	7.50	651.92	0.40	11411.50	6089003.49	801.18
Paultre et al.	1206040	1	12.01	12.01	10.50	1.51	78.74	78.74	7.50	944.16	0.41	15834.00	7172493.71	943.75
Paultre et al.	1005540	1	12.01	12.01	10.57	1.44	78.74	78.74	7.45	809.28	0.35	15877.50	7182339.28	945.04
Paultre et al.	1008040	1	12.01	12.01	10.57	1.44	78.74	78.74	7.45	809.28	0.37	15109.00	7006364.32	921.89
Paultre et al.	1005552	1	12.01	12.01	10.57	1.44	78.74	78.74	7.45	1157.72	0.53	15152.50	7016443.01	923.22
Paultre et al.	1006052	1	12.01	12.01	10.50	1.51	78.74	78.74	7.50	1157.72	0.51	15863.00	7179058.92	944.61
Pujol	10-3-1.5N	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	30.00	0.09	4658.79	3890553.50	511.91
Pujol	10-3-1.5S	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	30.00	0.09	4658.79	3890553.50	511.91
Bechtoula, Kono, Arai and Watanabe	D1N60	1	9.84	9.84	8.59	1.25	24.61	24.61	2.86	316.97	0.60	5452.00	4208746.61	553.78
Bechtoula, Kono, Arai and Watanabe	L1D60	1	23.62	23.62	20.87	2.75	47.24	47.24	2.26	1798.40	0.57	5684.00	4297361.52	565.44
Bechtoula, Kono, Arai and Watanabe	L1N60	1	23.62	23.62	21.21	2.41	47.24	47.24	2.23	1798.40	0.57	5684.00	4297361.52	565.44
Bechtoula, Kono, Arai and Watanabe	L1N6B	1	22.05	22.05	20.43	1.62	47.24	47.24	2.31	1348.80	0.59	4669.00	3894814.63	512.48
Nagasaka	HPRC19-32	1	7.87	7.87	6.94	0.94	23.62	11.81	1.70	66.09	0.35	3045.00	3145346.56	413.86
Zhou	204-08	0.4	6.30	6.30	5.42	0.88	25.20	12.60	2.32	97.11	0.80	3059.50	3152826.59	414.85
Zhou	223-09	0.4	6.30	6.30	5.42	0.88	25.20	12.60	2.32	109.25	0.90	3059.50	3152826.59	414.85
Zhou	302-07	0.4	6.30	6.30	5.42	0.88	37.80	18.90	3.48	116.22	0.70	4176.00	3683452.73	484.66
Zhou	312-07	0.4	6.30	6.30	5.42	0.88	37.80	18.90	3.48	116.22	0.70	4176.00	3683452.73	484.66
Ono	CA025C	1	7.87	7.87	6.70	1.17	23.62	11.81	1.76	59.57	0.26	3741.00	3486331.74	458.73
Ono	CA060C	1	7.87	7.87	6.70	1.17	23.62	11.81	1.76	142.97	0.62	3741.00	3486331.74	458.73
Amitsu	CB060C	0.308	10.95	10.95	9.35	1.59	25.43	12.72	1.36	591.67	0.74	6713.50	4670349.18	614.52
Wight	WI_40_147_E	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	40.01	0.11	4857.50	3972658.74	522.72
Wight	WI_40_147_W	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	40.01	0.11	4857.50	3972658.74	522.72
Wight	WI_40_092_E	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	40.01	0.11	4857.50	3972658.74	522.72
Wight	WI_40_092_W	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	40.01	0.11	4857.50	3972658.74	522.72
Iwasaki	I_25	0.2	19.69	19.69	17.70	1.99	45.67	45.67	2.58	0.00	0.00	4786.45	3943497.95	518.88
Nagasaka	HPRC_1063	1	7.87	7.87	6.94	0.94	23.62	11.81	1.70	33.08	0.17	3132.00	3189963.64	419.73
Zhou	UNIT_10408	0.4	6.30	6.30	5.42	0.88	12.60	6.30	1.16	91.27	0.80	2871.00	3054157.66	401.86
Zhou	UNIT_11408	0.4	6.30	6.30	5.42	0.88	12.60	6.30	1.16	91.27	0.80	2871.00	3054157.66	401.86
Zhou	UNIT_12408	0.4	6.30	6.30	5.42	0.88	12.60	6.30	1.16	91.27	0.80	2871.00	3054157.66	401.86

Table A-2-2: Longitudinal reinforcement data of condition i rectangular columns

	Longitudinal reinforcement details									Longitudinal steel properties		
	Tension face			Compression face			Middle layer					
Column designation	Number of bars perpendicular to load	Number of bars parallel to load	Bar dia. (in.)	Number of bars perpendicular to load	Number of bars parallel to load	Bar dia. (in.)	Number of bars perpendicular to load	Number of bars parallel to load	Bar dia. (in.)	f_{yl} (psi)	f_{ul} (psi)	ρ_l
No.1	4	1	0.94	4	1	0.94	2	2	0.94	54375.00	92162.00	0.018
No.2	4	1	0.94	4	1	0.94	2	2	0.94	54375.00	92162.00	0.018
No.3	4	1	0.94	4	1	0.94	2	2	0.94	54375.00	92162.00	0.018
No.4	4	1	0.94	4	1	0.94	2	2	0.94	54375.00	92162.00	0.018
No.3	4	1	0.63	4	1	0.63	2	2	0.63	61915.00	97150.00	0.015
No.4	4	1	0.63	4	1	0.63	2	2	0.63	61915.00	97150.00	0.015
No. 1	4	1	0.63	4	1	0.63	2	2	0.63	64670.00	101790.00	0.015
No. 2	4	1	0.63	4	1	0.63	2	2	0.63	64670.00	101790.00	0.015
No. 3	4	1	0.63	4	1	0.63	2	2	0.63	64670.00	101790.00	0.015
No.7	4	1	0.63	4	1	0.63	2	2	0.63	63800.00	97730.00	0.015
No.8	4	1	0.63	4	1	0.63	2	2	0.63	63800.00	97730.00	0.015
No.5	4	1	0.63	4	1	0.63	2	2	0.63	68730.00	91828.50	0.015
No.6	4	1	0.63	4	1	0.63	2	2	0.63	68730.00	91828.50	0.015
No.7	4	1	0.63	4	1	0.63	2	2	0.63	68730.00	91828.50	0.015
No.8	4	1	0.63	4	1	0.63	2	2	0.63	68730.00	91828.50	0.015
No.9	4	1	0.63	4	1	0.63	2	2	0.63	68730.00	91828.50	0.015
No1	3	1	0.79	3	1	0.79	2	1	0.79	68730.00	104545.00	0.016
No2	3	1	0.79	3	1	0.79	2	1	0.79	68730.00	104545.00	0.016
No3	3	1	0.79	3	1	0.79	2	1	0.79	68730.00	104545.00	0.016
No4	3	1	0.79	3	1	0.79	2	1	0.79	68730.00	104545.00	0.016
No5	4	1	0.79	4	1	0.79	2	2	0.79	74095.00	97875.00	0.012
No6	4	1	0.79	4	1	0.79	2	2	0.79	74095.00	97875.00	0.012
No7	4	1	0.79	4	1	0.79	2	2	0.79	74095.00	97875.00	0.012
No8	4	1	0.79	4	1	0.79	2	2	0.79	74095.00	97875.00	0.012

No9	3	1	0.95	3	1	0.95	2	2	0.95	62640.00	0.00	0.019
No.102	3	1	0.37	3	1	0.37	0	0	0.37	56956.00	0.00	0.007
L1	4	1	0.75	4	1	0.75	0	0	0.75	52490.00	0.00	0.014
L2	4	1	0.75	4	1	0.75	0	0	0.75	52490.00	0.00	0.014
L3	4	1	0.75	4	1	0.75	0	0	0.75	52490.00	0.00	0.014
214-08	3	1	0.37	3	1	0.37	2	1	0.37	49445.00	64960.00	0.022
85STC-1	3	1	0.50	3	1	0.50	2	1	0.50	54230.00	71630.00	0.016
85STC-2	3	1	0.50	3	1	0.50	2	1	0.50	54230.00	71630.00	0.016
85STC-3	3	1	0.50	3	1	0.50	2	1	0.50	54230.00	71630.00	0.016
85PDC-1	3	1	0.50	3	1	0.50	2	1	0.50	54230.00	71630.00	0.016
85PDC-2	3	1	0.50	3	1	0.50	2	1	0.50	54230.00	71630.00	0.016
85PDC-3	3	1	0.50	3	1	0.50	2	1	0.50	54230.00	71630.00	0.016
AL-1	4	1	0.50	4	1	0.50	2	1	0.50	57942.00	0.00	0.032
AH-1	4	1	0.50	4	1	0.50	2	2	0.50	57942.00	0.00	0.038
AL-2	4	1	0.50	4	1	0.50	2	2	0.50	57942.00	0.00	0.038
AH-2	4	1	0.50	4	1	0.50	2	2	0.50	57942.00	0.00	0.038
BH-1	4	1	0.50	4	1	0.50	2	2	0.50	57942.00	0.00	0.038
BL-2	4	1	0.50	4	1	0.50	2	2	0.50	57942.00	0.00	0.038
BH-2	4	1	0.50	4	1	0.50	2	2	0.50	57942.00	0.00	0.038
B2	4	1	0.50	4	1	0.50	2	2	0.50	54955.00	82795.00	0.024
B4	4	1	0.50	4	1	0.50	2	2	0.50	54955.00	82795.00	0.024
B5	4	1	0.50	4	1	0.50	2	2	0.50	54955.00	82795.00	0.024
No.1S1	2	1	0.87	2	1	0.87	0	0	0.87	53215.00	83810.00	0.016
No.3S1	2	1	0.87	2	1	0.87	0	0	0.87	53215.00	83810.00	0.016
No.5S1	2	1	0.87	2	1	0.87	0	0	0.87	62205.00	95265.00	0.016
No.9	2	1	0.87	2	1	0.87	0	0	0.87	52635.00	81635.00	0.016
No.11	2	1	0.87	2	1	0.87	0	0	0.87	52635.00	81635.00	0.016
NC 2	3	1	1.00	3	1	1.00	2	1	1.00	63655.00	106720.00	0.019
NC 4	3	1	1.00	3	1	1.00	2	1	1.00	63655.00	106720.00	0.019
U4	3	1	1.00	3	1	1.00	2	1	1.00	63510.00	0.00	0.033
U6	3	1	1.00	3	1	1.00	2	1	1.00	63365.00	0.00	0.033
U7	3	1	1.00	3	1	1.00	2	1	1.00	63365.00	0.00	0.033
BA1	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015

BA2	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015
BA3	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015
BA4	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015
CA1	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015
CA2	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015
CA3	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015
CA4	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015
BB4	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
BB4B	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
CB1	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
CB2	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
CB3	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
CB4	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
B1	4	1	0.75	4	1	0.75	2	5	0.75	64960.00	105995.00	0.022
B2	4	1	0.75	4	1	0.75	2	5	0.75	64960.00	105995.00	0.022
HC4-8L19-T10-0.1P	3	1	0.75	3	1	0.75	2	1	0.75	73950.00	0.00	0.036
HC4-8L19-T10-0.2P	3	1	0.75	3	1	0.75	2	1	0.75	73950.00	0.00	0.036
HC4-8L16-T10-0.1P	3	1	0.63	3	1	0.63	2	1	0.63	73950.00	0.00	0.025
HC4-8L16-T10-0.2P	3	1	0.63	3	1	0.63	2	1	0.63	73950.00	0.00	0.025
UC10H	4	1	0.39	4	1	0.39	2	2	0.39	56985.00	78735.00	0.019
UC15H	4	1	0.39	4	1	0.39	2	2	0.39	56985.00	78735.00	0.019
UC20H	4	1	0.39	4	1	0.39	2	2	0.39	56985.00	78735.00	0.019
UC15L	4	1	0.39	4	1	0.39	2	2	0.39	56985.00	78735.00	0.019
UC20L	4	1	0.39	4	1	0.39	2	2	0.39	56985.00	78735.00	0.019
ES-1HT	3	1	0.77	3	1	0.77	2	1	0.77	65830.00	101500.00	0.026
AS-2HT	3	1	0.77	3	1	0.77	2	1	0.77	65830.00	101500.00	0.026
AS-3HT	3	1	0.77	3	1	0.77	2	1	0.77	65830.00	101500.00	0.026
AS-4HT	3	1	0.77	3	1	0.77	2	1	0.77	65830.00	101500.00	0.026
AS-5HT	3	1	0.77	3	1	0.77	2	1	0.77	65830.00	101500.00	0.026

AS-6HT	3	1	0.77	3	1	0.77	2	1	0.77	65830.00	101500.00	0.026
AS-7HT	3	1	0.77	3	1	0.77	2	1	0.77	65830.00	101500.00	0.026
ES-8HT	3	1	0.77	3	1	0.77	2	1	0.77	65830.00	101500.00	0.026
BG-2	3	1	0.77	3	1	0.77	2	1	0.77	66055.56	95700.00	0.020
BG-3	3	1	0.77	3	1	0.77	2	1	0.77	66055.56	95700.00	0.020
BG-5	4	1	0.77	4	1	0.77	2	2	0.77	66055.56	95700.00	0.029
BG-6	2	1	1.18	2	1	1.18	0	0	1.18	69277.79	101500.00	0.023
BG-7	4	1	0.77	4	1	0.77	2	2	0.77	66055.56	95700.00	0.029
BG-8	4	1	0.77	4	1	0.77	2	2	0.77	66055.56	95700.00	0.029
BG-9	6	1	0.63	6	1	0.63	2	4	0.63	62027.78	97875.00	0.033
BG-10	6	1	0.63	6	1	0.63	2	4	0.63	62027.78	97875.00	0.033
C10-10N	2	1	0.63	2	1	0.63	0	0	0.63	82978.40	105972.42	0.019
C10-10S	2	1	0.63	2	1	0.63	0	0	0.63	83123.40	106117.42	0.019
C10-20N	2	1	0.63	2	1	0.63	0	0	0.63	82978.40	105972.42	0.019
C10-20S	2	1	0.63	2	1	0.63	0	0	0.63	83123.40	106117.42	0.019
C5-00N	2	1	0.63	2	1	0.63	0	0	0.63	82978.40	105722.48	0.019
C5-00S	2	1	0.63	2	1	0.63	0	0	0.63	83123.40	105867.48	0.019
C5-40N	2	1	0.63	2	1	0.63	0	0	0.63	82978.40	105722.48	0.019
C5-40S	2	1	0.63	2	1	0.63	0	0	0.63	83123.40	105867.48	0.019
C1-1	4	1	0.75	4	1	0.75	2	2	0.75	72065.00	85840.00	0.021
C1-2	4	1	0.75	4	1	0.75	2	2	0.75	72065.00	85840.00	0.021
C1-3	4	1	0.75	4	1	0.75	2	2	0.75	72065.00	85840.00	0.021
C2-1	4	1	0.75	4	1	0.75	2	2	0.75	72065.00	85840.00	0.021
C2-2	4	1	0.75	4	1	0.75	2	2	0.75	72065.00	85840.00	0.021
C2-3	4	1	0.75	4	1	0.75	2	2	0.75	72065.00	85840.00	0.021
C3-1	4	1	0.75	4	1	0.75	2	2	0.75	72065.00	85840.00	0.021
C3-2	4	1	0.75	4	1	0.75	2	2	0.75	72065.00	85840.00	0.021
C3-3	4	1	0.75	4	1	0.75	2	2	0.75	72065.00	85840.00	0.021
ORC1	3	1	0.98	3	1	0.98	2	1	0.98	60000.00	90000.00	0.025
ORC2	3	1	0.98	3	1	0.98	2	1	0.98	60000.00	90000.00	0.025
ORC3	3	1	0.98	3	1	0.98	2	1	0.98	60000.00	90000.00	0.025
A1	3	1	0.38	3	1	0.38	2	1	0.38	74979.50	129920.00	0.025
A3	3	1	0.38	3	1	0.38	2	1	0.38	74983.13	129920.00	0.025

B1	3	1	0.38	3	1	0.38	2	1	0.38	65989.50	109910.00	0.025
B2	3	1	0.38	3	1	0.38	2	1	0.38	65985.15	109910.00	0.025
B3	3	1	0.38	3	1	0.38	2	1	0.38	65985.15	109910.00	0.025
C1	3	1	0.38	3	1	0.38	2	1	0.38	68991.00	107010.00	0.025
C2	3	1	0.38	3	1	0.38	2	1	0.38	68984.48	107010.00	0.025
C3	3	1	0.38	3	1	0.38	2	1	0.38	68984.48	107010.00	0.025
D1	3	1	0.38	3	1	0.38	2	1	0.38	68984.48	107010.00	0.025
D2	3	1	0.38	3	1	0.38	2	1	0.38	68984.48	107010.00	0.025
D3	3	1	0.38	3	1	0.38	2	1	0.38	68984.48	107010.00	0.025
1006015	3	1	0.77	3	1	0.77	2	1	0.63	65395.00	103820.00	0.026
1006025	3	1	0.77	3	1	0.77	2	1	0.63	62350.00	95845.00	0.026
1006040	3	1	0.77	3	1	0.77	2	1	0.63	65395.00	103820.00	0.026
10013015	3	1	0.77	3	1	0.77	2	1	0.63	65395.00	103820.00	0.026
10013025	3	1	0.77	3	1	0.77	2	1	0.63	62350.00	95845.00	0.026
10013040	3	1	0.77	3	1	0.77	2	1	0.63	65395.00	104690.00	0.026
806040	3	1	0.77	3	1	0.77	2	1	0.63	64670.00	104255.00	0.026
1206040	3	1	0.77	3	1	0.77	2	1	0.63	64670.00	104255.00	0.026
1005540	3	1	0.77	3	1	0.77	2	1	0.63	64670.00	104255.00	0.026
1008040	3	1	0.77	3	1	0.77	2	1	0.63	64670.00	104255.00	0.026
1005552	3	1	0.77	3	1	0.77	2	1	0.63	64670.00	104255.00	0.026
1006052	3	1	0.77	3	1	0.77	2	1	0.63	64670.00	104255.00	0.026
10-3-1.5N	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
10-3-1.5S	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
D1N60	4	1	0.50	4	1	0.50	2	2	0.50	66845.00	91973.50	0.024
L1D60	4	1	1.00	4	1	1.00	2	2	1.00	56260.00	85260.00	0.017
L1N60	4	1	1.00	4	1	1.00	2	2	1.00	56260.00	85260.00	0.017
L1N6B	4	1	1.00	4	1	1.00	2	2	1.00	56260.00	85260.00	0.019
HPRC19-32	2	1	0.50	2	1	0.50	0	0	0.50	53795.00	78445.00	0.013
204-08	3	1	0.37	3	1	0.37	2	1	0.37	49445.00	64960.00	0.022
223-09	3	1	0.37	3	1	0.37	2	1	0.37	49445.00	64960.00	0.022
302-07	3	1	0.37	3	1	0.37	2	1	0.37	49445.00	64960.00	0.022
312-07	3	1	0.37	3	1	0.37	2	1	0.37	49445.00	64960.00	0.022
CA025C	4	1	0.37	4	1	0.37	2	2	0.37	52345.00	77285.00	0.021

CA060C	4	1	0.37	4	1	0.37	2	2	0.37	52345.00	77285.00	0.021
CB060C	5	1	0.51	5	1	0.51	2	3	0.51	63945.00	0.00	0.027
WI_40_147_E	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_40_147_W	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_40_092_E	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_40_092_W	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
I_25	11	1	0.51	11	1	0.51	2	9	0.51	46835.00	70252.50	0.021
HPRC_1063	2	1	0.50	2	1	0.50	0	0	0.50	53795.00	80692.50	0.01
UNIT_10408	3	1	0.37	3	1	0.37	2	1	0.37	49445.00	64960.00	0.02
UNIT_11408	3	1	0.37	3	1	0.37	2	1	0.37	49445.00	64960.00	0.02
UNIT_12408	3	1	0.37	3	1	0.37	2	1	0.37	49445.00	64960.00	0.02

Table A-2-3: Transverse reinforcement data of condition i rectangular columns

	Transverse reinforcement details				**Transverse steel properties**				
Column designation	Bar dia. (in.)	No. of bars perpendicular to load	No. of bars parallel to load	s (in.)	f_{yt} (psi)	f_{ut} (psi)	Vol. ρ_t	ρ''	s/d
No.1	0.39	4	4	3.15	43065.00	60436.00	0.015	0.007	0.16
No.2	0.47	4	4	2.95	45820.00	63887.00	0.023	0.011	0.15
No.3	0.39	4	4	2.95	43065.00	60436.00	0.020	0.008	0.15
No.4	0.47	4	4	2.44	42630.00	59798.00	0.035	0.013	0.13
No.3	0.47	4	4	3.94	46400.00	62930.00	0.028	0.011	0.28
No.4	0.39	4	4	3.54	40600.00	59160.00	0.022	0.009	0.25
No. 1	0.28	4	4	3.35	52780.00	75545.00	0.009	0.005	0.23
No. 2	0.31	4	4	3.07	52200.00	71340.00	0.012	0.006	0.21
No. 3	0.28	4	4	3.58	52780.00	75545.00	0.008	0.004	0.24
No.7	0.39	4	4	4.61	67570.00	99760.00	0.016	0.007	0.32
No.8	0.39	4	4	3.62	67570.00	99760.00	0.020	0.009	0.25
No.5	0.31	4	4	3.19	53940.00	74820.00	0.007	0.006	0.22
No.6	0.24	4	4	3.78	56260.00	75110.00	0.003	0.003	0.26
No.7	0.47	4	4	3.78	44660.00	64380.00	0.013	0.012	0.26
No.8	0.31	4	4	3.03	53940.00	74820.00	0.007	0.007	0.21
No.9	0.47	4	4	2.05	44660.00	64380.00	0.025	0.022	0.14
No1	0.47	3	3	3.15	48285.00	69745.00	0.025	0.011	0.24
No2	0.47	3	3	3.15	48285.00	69745.00	0.025	0.011	0.24
No3	0.47	3	3	3.15	48285.00	69745.00	0.025	0.011	0.24
No4	0.47	3	3	3.15	48285.00	69745.00	0.025	0.011	0.24
No5	0.47	4	4	4.33	47125.00	62205.00	0.017	0.007	0.23
No6	0.47	4	4	4.33	47125.00	62205.00	0.017	0.007	0.23
No7	0.47	4	4	3.54	47125.00	62205.00	0.021	0.009	0.18
No8	0.47	4	4	3.54	47125.00	62205.00	0.021	0.009	0.18
No9	0.47	3	3	3.15	44225.00	0.00	0.019	0.011	0.14
No.102	0.22	3	3	1.26	46835.00	0.00	0.012	0.009	0.15
L1	0.35	2	2	3.94	47125.00	0.00	0.003	0.003	0.29
L2	0.35	2	2	3.94	47125.00	0.00	0.003	0.003	0.29
L3	0.35	2	2	3.94	47125.00	0.00	0.003	0.003	0.29
214-08	0.20	2	2	1.57	81055.00	85405.00	0.007	0.006	0.29
85STC-1	0.22	2	2	1.97	73370.00	78300.00	0.004	0.004	0.22
85STC-2	0.22	2	2	1.97	73370.00	78300.00	0.004	0.004	0.25
85STC-3	0.22	2	2	1.97	73370.00	78300.00	0.004	0.004	0.25
85PDC-1	0.22	2	2	1.97	51040.00	0.00	0.004	0.004	0.25
85PDC-2	0.22	2	2	1.97	73370.00	78300.00	0.004	0.004	0.25
85PDC-3	0.22	2	2	1.97	73370.00	78300.00	0.004	0.004	0.25
AL-1	0.24	4	4	1.38	47618.00	0.00	0.016	0.016	0.20
AH-1	0.24	4	4	1.38	114883.50	0.00	0.016	0.016	0.20

AL-2	0.24	4	4	1.38	47618.00	0.00	0.016	0.016	0.20
AH-2	0.24	4	4	1.38	114883.50	0.00	0.016	0.016	0.20
BH-1	0.24	4	4	1.38	114883.50	0.00	0.016	0.016	0.20
BL-2	0.24	4	4	1.38	47618.00	0.00	0.016	0.016	0.20
BH-2	0.24	4	4	1.38	114883.50	0.00	0.016	0.016	0.20
B2	0.20	4	4	1.57	112230.00	124265.00	0.007	0.008	0.19
B4	0.20	4	4	2.36	163270.00	190675.00	0.005	0.005	0.28
B5	0.20	4	4	1.18	112230.00	124265.00	0.005	0.010	0.14
No.1S1	0.37	2	2	2.99	52635.00	7757.00	0.015	0.006	0.30
No.3S1	0.37	2	2	2.99	52635.00	77575.00	0.015	0.006	0.30
No.5S1	0.37	2	2	2.99	56840.00	76850.00	0.015	0.006	0.30
No.9	0.37	2	2	2.99	56840.00	76850.00	0.015	0.006	0.30
No.11	0.37	2	2	2.99	54085.00	71340.00	0.015	0.006	0.30
NC 2	0.50	3.414	3.414	4.02	65830.00	100920.00	0.022	0.009	0.26
NC 4	0.37	3.414	3.414	4.02	89320.00	101210.00	0.013	0.005	0.26
U4	0.39	2	2	1.97	68150.00	0.00	0.025	0.009	0.16
U6	0.25	6	6	2.56	61625.00	0.00	0.032	0.008	0.21
U7	0.25	6	6	2.56	61625.00	0.00	0.020	0.008	0.21
BA1	0.32	4	4	3.94	62350.00	0.00	0.018	0.008	0.48
BA2	0.31	4	4	3.94	62350.00	0.00	0.018	0.008	0.48
BA3	0.31	4	4	3.94	62350.00	0.00	0.018	0.008	0.48
BA4	0.31	4	4	3.94	62350.00	0.00	0.018	0.008	0.48
CA1	0.31	4	4	1.97	62350.00	0.00	0.037	0.016	0.24
CA2	0.31	4	4	1.97	62350.00	0.00	0.037	0.016	0.24
CA3	0.31	4	4	1.97	62350.00	0.00	0.037	0.016	0.24
CA4	0.31	4	4	1.97	62350.00	0.00	0.037	0.016	0.24
BB4	0.31	4	4	3.94	62350.00	0.00	0.018	0.008	0.50
BB4B	0.31	4	4	3.94	62350.00	0.00	0.018	0.008	0.50
CB1	0.31	4	4	1.97	62350.00	0.00	0.037	0.016	0.25
CB2	0.31	4	4	1.97	62350.00	0.00	0.037	0.016	0.25
CB3	0.31	4	4	1.97	62350.00	0.00	0.037	0.016	0.25
CB4	0.31	4	4	1.97	62350.00	0.00	0.037	0.016	0.25
B1	0.24	4	4	3.27	62060.00	107010.00	0.005	0.004	0.15
B2	0.24	4	4	3.27	62060.00	107010.00	0.005	0.004	0.15
HC4-8L19-T10-0.1P	0.37	3	3	2.01	73950.00	0.00	0.037	0.016	0.23
HC4-8L19-T10-0.2P	0.37	3	3	2.01	73950.00	0.00	0.037	0.016	0.23
HC4-8L16-T10-0.1P	0.37	3	3	2.01	73950.00	0.00	0.037	0.016	0.23
HC4-8L16-T10-0.2P	0.37	3	3	2.01	73950.00	0.00	0.037	0.016	0.23
UC10H	0.20	4	4	1.77	205175.00	214020.00	0.032	0.008	0.22
UC15H	0.25	4	4	1.77	206480.00	219675.00	0.050	0.013	0.22
UC20H	0.25	4	4	1.38	206480.00	219675.00	0.050	0.016	0.17
UC15L	0.25	4	4	1.77	206480.00	219675.00	0.050	0.013	0.22
UC20L	0.25	4	4	1.38	206480.00	219675.00	0.050	0.016	0.17
ES-1HT	0.63	2	2	3.74	67135.00	93960.00	0.032	0.014	0.35

AS-2HT	0.44	3.414	3.414	3.54	78590.00	99035.00	0.028	0.012	0.33
AS-3HT	0.44	3.414	3.414	3.54	78590.00	99035.00	0.028	0.012	0.33
AS-4HT	0.63	3.414	3.414	3.94	67135.00	93960.00	0.051	0.022	0.37
AS-5HT	0.63	3.414	3.414	3.54	67135.00	93960.00	0.040	0.025	0.34
AS-6HT	0.63	3.414	3.414	2.99	67135.00	93960.00	0.067	0.030	0.28
AS-7HT	0.44	3.414	3.414	3.70	78590.00	99035.00	0.027	0.012	0.35
ES-8HT	0.63	3.414	3.414	2.76	67135.00	93960.00	0.043	0.032	0.26
BG-2	0.38	3	3	2.99	82650.00	98600.00	0.020	0.008	0.25
BG-3	0.38	3	3	2.99	82650.00	98600.00	0.020	0.008	0.25
BG-5	0.38	4	4	2.99	82650.00	98600.00	0.027	0.011	0.25
BG-6	0.38	4	4	2.99	82650.00	98600.00	0.027	0.011	0.26
BG-7	0.26	4	4	2.99	84100.00	104400.00	0.013	0.005	0.25
BG-8	0.26	4	4	2.99	84100.00	104400.00	0.013	0.005	0.25
BG-9	0.26	4	4	2.99	84100.00	104400.00	0.013	0.005	0.25
BG-10	0.38	4	4	2.99	82650.00	98600.00	0.027	0.011	0.25
C10-10N	0.37	2	2	3.00	74480.61	110221.31	0.010	0.009	0.48
C10-10S	0.37	2	2	3.04	74625.61	110366.31	0.010	0.009	0.48
C10-20N	0.37	2	2	3.00	74480.61	110221.31	0.010	0.009	0.47
C10-20S	0.37	2	2	3.04	74625.61	110366.31	0.010	0.009	0.45
C5-00N	0.37	2	2	3.00	74480.61	110221.31	0.010	0.009	0.47
C5-00S	0.37	2	2	3.04	74625.61	110366.31	0.010	0.009	0.49
C5-40N	0.37	2	2	3.00	74480.61	110221.31	0.010	0.009	0.46
C5-40S	0.37	2	2	3.04	74625.61	110366.31	0.010	0.009	0.47
C1-1	0.25	4	4	1.97	66627.50	83592.50	0.030	0.006	0.14
C1-2	0.25	4	4	1.97	66627.50	83592.50	0.030	0.006	0.14
C1-3	0.25	4	4	1.97	66627.50	83592.50	0.030	0.006	0.14
C2-1	0.25	4	4	2.05	66627.50	83592.50	0.030	0.006	0.15
C2-2	0.25	4	4	2.05	66627.50	83592.50	0.030	0.006	0.15
C2-3	0.25	4	4	2.05	66627.50	83592.50	0.030	0.006	0.15
C3-1	0.25	4	4	2.13	66627.50	83592.50	0.030	0.006	0.15
C3-2	0.25	4	4	2.13	66627.50	83592.50	0.030	0.006	0.15
C3-3	0.25	4	4	2.13	66627.50	83592.50	0.030	0.006	0.15
ORC1	0.39	4	4	2.95	60000.00	90000.00	0.052	0.014	0.16
ORC2	0.39	4	4	2.95	60000.00	90000.00	0.052	0.014	0.16
ORC3	0.39	4	4	2.95	60000.00	90000.00	0.052	0.014	0.16
A1	0.13	3	3	1.00	114985.00	118030.00	0.014	0.006	0.19
A3	0.13	3	3	1.00	114985.00	118030.00	0.014	0.006	0.19
B1	0.13	3.414	3.414	1.00	114985.00	118030.00	0.016	0.007	0.19
B2	0.13	3.414	3.414	1.00	114985.00	118030.00	0.016	0.007	0.19
B3	0.13	3.414	3.414	1.00	114985.00	118030.00	0.016	0.007	0.19
C1	0.13	3.414	3.414	1.00	182990.00	209960.00	0.016	0.007	0.19
C2	0.13	3.414	3.414	1.00	182990.00	209960.00	0.016	0.007	0.19
C3	0.13	3.414	3.414	1.00	182990.00	209960.00	0.016	0.007	0.19
D1	0.13	3.414	3.414	1.25	182990.00	209960.00	0.016	0.006	0.24
D2	0.13	3.414	3.414	1.50	182990.00	209960.00	0.016	0.005	0.29
D3	0.13	3.414	3.414	1.75	182990.00	209960.00	0.016	0.004	0.33
1006015	0.44	3.414	3.414	2.36	56695.00	92365.00	0.100	0.019	0.22
1006025	0.44	3.414	3.414	2.36	56695.00	92365.00	0.100	0.019	0.22

1006040	0.44	3.414	3.414	2.36	60610.00	97875.00	0.100	0.019	0.22
10013015	0.44	3.414	3.414	5.12	56695.00	92365.00	0.100	0.009	0.49
10013025	0.44	3.414	3.414	5.12	56695.00	92365.00	0.100	0.009	0.49
10013040	0.44	3.414	3.414	5.12	60610.00	97875.00	0.100	0.009	0.49
806040	0.44	3.414	3.414	2.36	63510.00	99905.00	0.100	0.019	0.22
1206040	0.44	3.414	3.414	2.36	63510.00	99905.00	0.100	0.019	0.22
1005540	0.37	3.414	3.414	2.17	119625.00	139200.00	0.070	0.014	0.20
1008040	0.37	3.414	3.414	3.15	119625.00	139200.00	0.070	0.010	0.30
1005552	0.44	3.414	3.414	2.17	107880.00	126730.00	0.098	0.020	0.20
1006052	0.44	3.414	3.414	2.36	71340.00	103675.00	0.100	0.019	0.22
10-3-1.5N	0.25	2	2	1.50	59580.50	76386.00	0.020	0.011	0.14
10-3-1.5S	0.25	2	2	1.50	59580.50	76386.00	0.020	0.011	0.14
D1N60	0.16	4	4	1.57	70325.00	87884.50	0.019	0.005	0.18
L1D60	0.50	4	4	3.94	75980.00	97585.00	0.078	0.008	0.19
L1N60	0.50	4	4	3.94	75980.00	97585.00	0.076	0.008	0.19
L1N6B	0.50	4	4	3.94	75980.00	97585.00	0.076	0.009	0.19
HPRC19-32	0.22	2	2	0.79	49880.00	62930.00	0.014	0.012	0.11
204-08	0.20	2	2	1.57	81055.00	85405.00	0.007	0.006	0.29
223-09	0.20	3.414	3.414	1.57	81055.00	85405.00	0.018	0.010	0.29
302-07	0.20	2	2	1.57	81055.00	85405.00	0.007	0.006	0.29
312-07	0.20	2	2	1.57	81055.00	85405.00	0.007	0.006	0.29
CA025C	0.24	4	4	2.76	61770.00	86275.00	0.009	0.008	0.41
CA060C	0.24	4	4	2.76	61770.00	86275.00	0.009	0.008	0.41
CB060C	0.24	4	4	2.05	60030.00	0.00	0.009	0.008	0.22
WI_40_147_E	0.37	2	2	2.52	45965.00	69890.00	0.015	0.015	0.25
WI_40_147_W	0.37	2	2	2.52	45965.00	69890.00	0.015	0.015	0.25
WI_40_092_E	0.37	2	2	4.02	45965.00	69890.00	0.009	0.009	0.40
WI_40_092_W	0.37	2	2	4.02	45965.00	69890.00	0.009	0.009	0.40
I_25	0.35	4	4	1.97	37468.00	56202.00	0.024	0.010	0.11
HPRC_1063	0.22	2	2	1.38	49880.00	74820.00	0.008	0.007	0.20
UNIT_10408	0.20	2	2	1.57	81055.00	85405.00	0.007	0.006	0.29
UNIT_11408	0.20	2	2	1.57	81055.00	85405.00	0.007	0.006	0.29
UNIT_12408	0.20	3.414	3.414	1.57	81055.00	85405.00	0.018	0.010	0.29

Table A-2-4: Test configurations and modes of failure of condition i rectangular columns

Column designation	Test configuration	Failure mode (by column behavior)
No.1	2	1
No.2	2	1
No.3	2	1
No.4	2	1
No.3	2	1
No.4	2	1
No. 1	2	1
No. 2	2	1
No. 3	2	1
No.7	2	1
No.8	2	1
No.5	2	1
No.6	2	1
No.7	2	1
No.8	2	1
No.9	2	1
No1	2	1
No2	2	1
No3	2	1
No4	2	1
No5	1	1
No6	1	1
No7	1	1
No8	1	1
No9	1	1
No.102	3	1
L1	1	1
L2	1	1
L3	1	1
214-08	3	1
85STC-1	3	1
85STC-2	3	1
85STC-3	3	1
85PDC-1	3	1
85PDC-2	3	1
85PDC-3	3	1
AL-1	2	1
AH-1	2	1
AL-2	2	1
AH-2	2	1
BH-1	2	1
BL-2	2	1
BH-2	2	1

Column designation	Test configuration	Failure mode (by column behavior)
B2	3	1
B4	3	1
B5	3	1
No.1S1	2	1
No.3S1	2	1
No.5S1	2	1
No.9	2	1
No.11	2	1
NC 2	2	1
NC 4	2	1
U4	1	1
U6	1	1
U7	1	1
BA1	2	1
BA2	2	1
BA3	2	1
BA4	2	1
CA1	2	1
CA2	2	1
CA3	2	1
CA4	2	1
BB4	2	1
BB4B	2	1
CB1	2	1
CB2	2	1
CB3	2	1
CB4	2	1
B1	2	1
B2	2	1
HC4-8L19-T10-0.1P	3	1
HC4-8L19-T10-0.2P	3	1
HC4-8L16-T10-0.1P	3	1
HC4-8L16-T10-0.2P	3	1
UC10H	3	1
UC15H	3	1
UC20H	3	1
UC15L	3	1
UC20L	3	1
ES-1HT	1	1

Column designation	Test configuration	Failure mode (by column behavior)
AS-2HT	1	1
AS-3HT	1	1
AS-4HT	1	1
AS-5HT	1	1
AS-6HT	1	1
AS-7HT	1	1
ES-8HT	1	1
BG-2	1	1
BG-3	1	1
BG-5	1	1
BG-6	1	1
BG-7	1	1
BG-8	1	1
BG-9	1	1
BG-10	1	1
C10-10N	1	1
C10-10S	1	1
C10-20N	1	1
C10-20S	1	1
C5-00N	1	1
C5-00S	1	1
C5-40N	1	1
C5-40S	1	1
C1-1	1	1
C1-2	1	1
C1-3	1	1
C2-1	1	1
C2-2	1	1
C2-3	1	1
C3-1	1	1
C3-2	1	1
C3-3	1	1
ORC1	1	1
ORC2	1	1
ORC3	1	1
A1	1	1
A3	1	1
B1	1	1
B2	1	1
B3	1	1
C1	1	1
C2	1	1
C3	1	1
D1	1	1
D2	1	1
D3	1	1
1006015	1	1
1006025	1	1
1006040	1	1
10013015	1	1
10013025	1	1
10013040	1	1
806040	1	1
1206040	1	1
1005540	1	1
1008040	1	1
1005552	1	1
1006052	1	1
10-3-1.5N	3	1
10-3-1.5S	3	1
D1N60	1	1
L1D60	1	1
L1N60	1	1
L1N6B	1	1
HPRC19-32	3	2
204-08	3	2
223-09	3	2
302-07	3	2
312-07	3	2
CA025C	3	2
CA060C	3	2
CB060C	3	2
WI_40_147_E	2	2
WI_40_147_W	2	2
WI_40_092_E	2	2
WI_40_092_W	2	2
I_25	1	2
HPRC_1063	3	3
UNIT_10408	3	3
UNIT_11408	3	3
UNIT_12408	3	3

Table A-2-5: Reported and calculated data of condition ii rectangular columns

			Specimen dimensions							Axial load		Concrete properties		
Author	Column designation	Scale factor	h (in.)	b (in.)	d (in.)	d' (in.)	L (in.)	a (in.)	a/d	P (kips)	$\frac{P}{A_g f_c'}$	f_c' (psi)	E_c (psi)	f_r (psi)
Soesianawati et al.	No. 4	1	15.75	15.75	14.69	1.06	62.99	62.99	4.29	431.62	0.30	5800.00	4340990.67	571.18
Mugurma et al.	BL-1	1	7.87	7.87	7.03	0.84	19.69	19.69	2.80	264.36	0.25	16791.00	7386065.19	971.85
Sakai et al.	B1	1	9.84	9.84	8.47	1.37	39.37	19.69	2.32	489.16	0.35	14427.50	6846528.13	900.86
Sakai et al.	B3	1	9.84	9.84	8.45	1.39	39.37	19.69	2.33	489.16	0.35	14427.50	6846528.13	900.86
Sakai et al.	B6	1	9.84	9.84	8.39	1.45	39.37	19.69	2.35	489.16	0.35	14427.50	6846528.13	900.86
Sakai et al.	B7	1	9.84	9.84	8.07	1.77	39.37	19.69	2.44	489.17	0.35	14427.50	6846528.13	900.86
Atalay and Penzein	No.2S1	1	12.01	12.01	9.94	2.07	65.98	65.98	6.64	60.02	0.09	4451.50	3803015.05	500.40
Atalay and Penzein	No.4S1	1	12.01	12.01	9.94	2.07	65.98	65.98	6.64	60.02	0.10	4002.00	3605897.67	474.46
Atalay and Penzein	No.6S1	1	12.01	12.01	9.94	2.07	65.98	65.98	6.64	120.04	0.18	4611.00	3870547.64	509.28
Atalay and Penzein	No.10	1	12.01	12.01	9.94	2.07	65.98	65.98	6.64	180.06	0.27	4698.00	3906891.60	514.06
Atalay and Penzein	No.12	1	12.01	12.01	9.94	2.07	65.98	65.98	6.64	180.06	0.27	4611.00	3870547.64	509.28
Saatcioglu and Ozcebe	U1	1	13.78	13.78	12.00	1.78	39.37	39.37	3.28	0.00	0.00	6322.00	4532127.32	596.33
Saatcioglu and Ozcebe	U3	1	13.78	13.78	12.00	1.78	39.37	39.37	3.28	134.88	0.14	5046.00	4049006.54	532.76
Galeota et al.	AA1	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	337.20	0.30	11600.00	6139087.88	807.77
Galeota et al.	AA2	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	337.20	0.30	11600.00	6139087.88	807.77
Galeota et al.	AA3	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	AA4	1	9.84	9.84	8.15	1.69	44.88	44.88	5.51	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	AB1	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	AB2	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	337.20	0.30	11600.00	6139087.88	807.77
Galeota et al.	AB3	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	337.20	0.30	11600.00	6139087.88	807.77

Galeota et al.	AB4	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	BB	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	224.80	0.20	11600.00	6139087.88	807.77
Galeota et al.	BB1	1	9.84	9.84	7.95	1.89	44.88	44.88	5.64	224.80	0.20	11600.00	6139087.88	807.77
Wehbe et al.	A1	1	24.02	14.96	22.30	1.71	91.93	91.93	4.12	138.25	0.10	3944.00	3579672.61	471.01
Wehbe et al.	A2	1	24.02	14.96	22.30	1.71	91.93	91.93	4.12	338.32	0.24	3944.00	3579672.61	471.01
Nosho et al	No.1	1	11.00	11.00	9.44	1.56	84.02	84.02	8.90	241.88	0.34	5887.00	4373426.92	575.45
Saatcioglu and Giria	BG-1	1	13.78	13.78	11.88	1.90	64.76	64.76	5.45	400.59	0.43	4930.00	4002195.65	526.60
Saatcioglu and Giria	BG-4	1	13.78	13.78	11.88	1.90	64.76	64.76	5.45	432.29	0.46	4930.00	4002195.65	526.60
Matamoros et al.	C10-05N	1	7.99	7.99	5.73	2.26	24.02	24.02	4.19	31.92	0.05	10097.37	5727683.69	753.64
Matamoros et al.	C10-05S	1	7.99	7.99	5.74	2.25	24.02	24.02	4.19	31.92	0.05	10097.37	5727683.69	753.64
Matamoros et al.	C5-20N	1	7.99	7.99	5.80	2.19	24.02	24.02	4.14	64.07	0.14	6998.18	4768341.59	627.41
Matamoros et al.	C5-20S	1	7.99	7.99	5.77	2.22	24.02	24.02	4.16	64.07	0.14	6998.18	4768341.59	627.41
Pujol	10-2-3N	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	30.00	0.09	4888.73	3985408.69	524.40
Pujol	10-2-3S	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	30.00	0.09	4888.73	3985408.69	524.40
Pujol	10-3-3N	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	30.00	0.10	4338.87	3754596.74	494.03
Pujol	10-3-3S	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	30.00	0.10	4338.87	3754596.74	494.03
Pujol	10-3-2.25N	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	30.00	0.10	3968.97	3590985.79	472.50
Pujol	10-3-2.25S	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	30.00	0.10	3968.97	3590985.79	472.50
Pujol	20-3-3N	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	60.00	0.16	5278.63	4141287.63	544.91
Pujol	20-3-3S	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	60.00	0.16	5278.63	4141287.63	544.91
Pujol	10-2-2.25N	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	30.00	0.08	5058.69	4054092.86	533.43
Pujol	10-2-2.25S	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	30.00	0.08	5058.69	4054092.86	533.43
Pujol	10-1-2.25N	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	29.90	0.08	5292.50	4146725.52	545.62
Pujol	10-1-2.25S	1	12.00	6.00	10.38	1.63	54.00	27.00	2.60	29.90	0.08	5292.50	4146725.52	545.62
Bechtoula, Kono, Arai and Watanabe	D1N30	1	9.84	9.84	8.59	1.25	24.61	24.61	2.86	158.48	0.30	5452.00	4208746.61	553.78
Takemura and Kawashima	Test 1	1	15.75	15.75	14.18	1.57	49.02	49.02	3.46	35.29	0.03	5205.50	4112501.61	541.12

Takemura and Kawashima	Test 2	1	15.75	15.75	14.18	1.57	49.02	49.02	3.46	35.29	0.03	5176.50	4101030.18	539.61
Takemura and Kawashima	Test 3	1	15.75	15.75	14.18	1.57	49.02	49.02	3.46	35.29	0.03	4973.50	4019813.62	528.92
Takemura and Kawashima	Test 4	1	15.75	15.75	14.18	1.57	49.02	49.02	3.46	35.29	0.03	4814.00	3954830.72	520.37
Takemura and Kawashima	Test 5	1	15.75	15.75	14.18	1.57	49.02	49.02	3.46	35.29	0.03	5336.00	4163731.98	547.86
Takemura and Kawashima	Test 6	1	15.75	15.75	14.18	1.57	49.02	49.02	3.46	35.29	0.03	5205.50	4112501.61	541.12
Ohue	2D16RS	1	7.87	7.87	6.91	0.96	31.50	15.75	2.28	41.14	0.14	4640.00	3882700.09	510.88
Ohue	4D13RS	1	7.87	7.87	6.91	0.97	31.50	15.75	2.28	41.14	0.15	4335.50	3753137.29	493.83
Zhou	1007	0.2	3.15	3.15	2.48	0.67	6.30	3.15	1.27	34.17	0.70	4930.00	4002195.65	526.60
Wight	WI_40_048E	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	40.01	0.15	3784.50	3506542.53	461.39
Wight	WI_40_048W	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	40.01	0.15	3784.50	3506542.53	461.39
Wight	WI_25_033_E	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	24.95	0.07	4872.00	3978583.67	523.50
Wight	WI_25_033_W	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	24.95	0.07	4872.00	3978583.67	523.50
Wight	WI_0_048W	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	0.00	0.00	3749.70	3490383.26	459.26
Wight	WI_40_067_E	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	40.01	0.11	4843.00	3966724.97	521.94
Wight	WI_40_067_W	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	40.01	0.11	4843.00	3966724.97	521.94
Lynn	2CLH18	1	18.00	18.00	15.63	2.37	116.00	58.00	3.71	113.07	0.07	4799.50	3948870.15	519.59
Lynn	2CMH18	1	18.00	18.00	15.63	2.37	116.00	58.00	3.71	339.90	0.28	3697.50	3466003.10	456.05
Lynn	2SLH18	1	18.00	18.00	15.63	2.37	116.00	58.00	3.71	113.07	0.07	4799.50	3948870.15	519.59
Lynn	3SMD12	1	18.00	18.00	15.50	2.50	116.00	58.00	3.74	339.90	0.28	3697.50	3466003.10	456.05
Xiao	HC4-8L16-T6-0.1P	0.5	10.00	10.00	8.92	1.08	40.00	20.00	2.24	120.04	0.10	12470.00	6365141.79	837.52
Xiao	HC4-8L16-T6-0.2P	0.5	10.00	10.00	8.92	1.08	40.00	20.00	2.24	240.09	0.19	12470.00	6365141.79	837.52
Sezen	Specimen_1	1	18.00	18.00	15.44	2.56	116.00	58.00	3.76	149.94	0.15	3059.50	3152826.59	414.85
Sezen	Specimen_2	1	18.00	18.00	15.44	2.56	116.00	58.00	3.76	599.99	0.61	3059.50	3152826.59	414.85
Sezen	Specimen_4	1	18.00	18.00	15.44	2.56	116.00	58.00	3.76	149.94	0.15	3161.00	3204697.96	421.67
Iwasaki	I_03	0.2	15.75	31.50	13.05	2.70	94.49	94.49	7.24	0.00	0.00	4457.30	3805491.78	500.72
Iwasaki	I_04	0.2	15.75	31.50	13.05	2.70	94.49	94.49	7.24	0.00	0.00	4116.55	3657139.72	481.20
Iwasaki	I_10	0.2	19.69	19.69	17.70	1.99	98.43	98.43	5.56	0.00	0.00	4525.45	3834473.50	504.54

Iwasaki	I_14	0.2	19.69	19.69	17.70	1.99	98.43	98.43	5.56	0.00	0.00	4641.45	3883306.72	510.96
Iwasaki	I_16	0.2	19.69	19.69	17.70	1.99	98.43	98.43	5.56	0.00	0.00	4612.45	3871156.16	509.36
Iwasaki	I_17	0.2	19.69	19.69	17.70	1.99	68.90	68.90	3.89	0.00	0.00	4613.90	3871764.60	509.44
Iwasaki	I_20	0.2	19.69	19.69	17.70	1.99	68.90	68.90	3.89	0.00	0.00	4825.60	3959592.71	521.00
Ikeda	IK_43	0.1	7.87	7.87	6.81	1.06	19.69	19.69	2.89	17.64	0.10	2840.55	3037918.19	399.73
Ikeda	IK_44	0.1	7.87	7.87	6.81	1.06	19.69	19.69	2.89	17.64	0.10	2840.55	3037918.19	399.73
Ikeda	IK_45	0.1	7.87	7.87	6.81	1.06	19.69	19.69	2.89	35.28	0.20	2840.55	3037918.19	399.73
Ikeda	IK_46	0.1	7.87	7.87	6.81	1.06	19.69	19.69	2.89	35.28	0.20	2840.55	3037918.19	399.73
Ikeda	IK_62	0.1	7.87	7.87	6.81	1.06	19.69	19.69	2.89	17.64	0.10	2840.55	3037918.19	399.73
Ikeda	IK_63	0.1	7.87	7.87	6.81	1.06	19.69	19.69	2.89	35.28	0.20	2840.55	3037918.19	399.73
Ikeda	IK_64	0.1	7.87	7.87	6.81	1.06	19.69	19.69	2.89	35.28	0.20	2840.55	3037918.19	399.73
Umemura & Endo	UM_205	0.1	7.87	7.87	7.09	0.79	23.62	23.62	3.33	35.28	0.22	2550.55	2878669.30	378.77
Umemura & Endo	UM_214	0.1	7.87	7.87	7.09	0.79	23.62	23.62	3.33	88.21	0.56	2550.55	2878669.30	378.77
Umemura & Endo	UM_220	0.1	7.87	7.87	7.09	0.79	31.50	15.75	2.22	35.28	0.12	4770.50	3936921.96	518.02
Umemura & Endo	UM_231	0.1	7.87	7.87	7.09	0.79	31.50	15.75	2.22	35.28	0.27	2140.20	2636950.85	346.97
Umemura & Endo	UM_232	0.1	7.87	7.87	7.09	0.79	31.50	15.75	2.22	35.28	0.30	1899.50	2484245.46	326.87
Umemura & Endo	UM_233	0.1	7.87	7.87	7.09	0.79	31.50	15.75	2.22	35.28	0.28	2019.85	2561736.26	337.07
Umemura & Endo	UM_234	0.1	7.87	7.87	7.09	0.79	31.50	15.75	2.22	35.28	0.30	1899.50	2484245.46	326.87
Kokusho	KO_372	0.1	7.87	7.87	6.69	1.18	19.69	19.69	2.94	35.28	0.20	2879.70	3058781.67	402.47
Kokusho	KO_373	0.1	7.87	7.87	6.69	1.18	19.69	19.69	2.94	35.28	0.19	2960.90	3101606.70	408.11
Kokusho & Fukuhara	KO_452	0.1	7.87	7.87	6.69	1.18	19.69	19.69	2.94	88.21	0.45	3179.85	3214239.05	422.93
Kokusho & Fukuhara	KO_454	0.1	7.87	7.87	6.69	1.18	19.69	19.69	2.94	88.21	0.45	3179.85	3214239.05	422.93
Elwood	Specimen1	0.5	9.00	9.00	7.76	1.24	57.99	29.00	3.74	28.77	0.10	3552.50	3397362.58	447.02
Elwood	Specimen2	0.5	9.00	9.00	7.76	1.24	57.99	29.00	3.74	68.11	0.24	3465.50	3355504.36	441.51
Saatcioglu	U2	1	13.78	13.78	12.01	1.77	39.37	39.37	3.28	134.88	0.16	4379.00	3771918.74	496.31
Esaki	H-2-1_3	0.333	7.87	7.87	6.89	0.98	31.50	15.75	2.29	71.74	0.35	3340.00	3294185.79	433.45

Esaki	H-2-1_5	0.333	7.87	7.87	6.89	0.98	31.50	15.75	2.29	43.09	0.21	3340.00	3294185.79	433.45
Esaki	HT-2-1_3	0.333	7.87	7.87	6.89	0.98	31.50	15.75	2.29	62.88	0.35	2930.00	3085380.04	405.97
Esaki	HT-2-1_5	0.333	7.87	7.87	6.89	0.98	31.50	15.75	2.29	37.77	0.21	2930.00	3085380.04	405.97
Lynn	3CMD12	1	18.00	18.00	15.50	2.50	116.00	58.00	3.74	339.90	0.26	4002.00	3605897.67	474.46
Yoshimura	Unit_6	0.5	11.81	11.81	10.04	1.77	47.24	23.62	2.35	124.22	0.20	4451.50	3803015.05	500.40
Yarandi	SRC	1	27.56	13.78	24.95	2.61	59.06	59.06	2.37	339.00	0.15	6090.00	4448191.77	585.29
Pandey	A4	1	11.81	11.81	10.24	1.58	25.59	25.59	2.50	20.23	0.03	4795.15	3947080.23	519.35
Yoshimura	FS0	1	11.81	11.81	10.04	1.77	35.43	35.43	3.53	142.03	0.26	3915.00	3566487.77	469.27
Yoshimura	FS1	1	11.81	11.81	10.04	1.77	35.43	35.43	3.53	142.03	0.26	3915.00	3566487.77	469.27
Umehara	CUW	0.667	9.06	16.14	7.46	1.59	35.83	17.91	2.40	120.15	0.16	5060.50	4054819.91	533.53
Iwasaki	I18	0.2	19.69	19.69	17.70	1.99	39.37	39.37	2.22	0.00	0.00	4799.50	3948870.15	519.59
Iwasaki	I21	0.2	19.69	19.69	17.70	1.99	39.37	39.37	2.22	0.00	0.00	4599.40	3865675.96	508.64
Ousalem	C1	0.333	11.81	11.81	10.24	1.58	35.43	17.72	1.73	81.94	0.30	1957.50	2521887.69	331.83
Ousalem	C4	0.333	11.81	11.81	10.24	1.58	35.43	17.72	1.73	81.94	0.30	1957.50	2521887.69	331.83
Ousalem	C8	0.333	11.81	11.81	10.24	1.58	35.43	17.72	1.73	109.25	0.30	2610.00	2912025.07	383.16
Ousalem	C12	0.333	11.81	11.81	10.24	1.58	35.43	17.72	1.73	72.84	0.20	2610.00	2912025.07	383.16
Ousalem	D1	0.333	11.81	11.81	10.24	1.58	23.62	11.81	1.15	121.39	0.22	4016.50	3612424.19	475.32
Ousalem	D13	0.333	11.81	11.81	10.24	1.58	35.43	17.72	1.73	121.39	0.23	3784.50	3506542.53	461.39
Ousalem	D14	0.333	11.81	11.81	10.24	1.58	35.43	17.72	1.73	121.39	0.23	3784.50	3506542.53	461.39
Ousalem	D16	0.333	11.81	11.81	10.24	1.58	23.62	11.81	1.15	121.39	0.23	3784.50	3506542.53	461.39
Wight	WI_0_033E	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	0.00	0.00	4640.00	3882700.09	510.88

Table A-2-6: Longitudinal reinforcement data of condition ii rectangular columns

	Longitudinal reinforcement details									Longitudinal steel properties		
	Tension face			Compression face			Middle layer					
Column designation	Number of bars perpendicular to load	Number of bars parallel to load	Bar dia (in.)	Number of bars perpendicular to load	Number of bars parallel to load	Bar dia. (in.)	Number of bars perpendicular to load	Number of bars parallel to load	Bar dia (in.)	f_{yl} (psi)	f_{ul} (psi)	ρ_l
No. 4	4	1	0.63	4	1	0.63	2	2	0.63	64670.00	101790.00	0.015
BL-1	4	1	0.50	4	1	0.50	2	2	0.50	57942.00	0.00	0.038
B1	4	1	0.50	4	1	0.50	2	2	0.50	54955.00	82795.00	0.024
B3	4	1	0.50	4	1	0.50	2	2	0.50	54955.00	82795.00	0.024
B6	4	1	0.50	4	1	0.50	2	2	0.50	54955.00	82795.00	0.024
B7	2	1	0.75	2	1	0.75	0	0	0.75	49155.00	74240.00	0.018
No.2S1	2	1	0.87	2	1	0.87	0	0	0.87	53215.00	83810.00	0.016
No.4S1	2	1	0.87	2	1	0.87	0	0	0.87	62205.00	95265.00	0.016
No.6S1	2	1	0.87	2	1	0.87	0	0	0.87	62205.00	95265.00	0.016
No.10	2	1	0.87	2	1	0.87	0	0	0.87	52635.00	81635.00	0.016
No.12	2	1	0.87	2	1	0.87	0	0	0.87	52635.00	81635.00	0.016
U1	3	1	1.00	3	1	1.00	2	1	1.00	62350.00	0.00	0.033
U3	3	1	1.00	3	1	1.00	2	1	1.00	62350.00	0.00	0.033
AA1	4	1	0.39	4	1	0.39	4	1	0.39	62350.00	0.00	0.015
AA2	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015
AA3	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015
AA4	4	1	0.39	4	1	0.39	2	2	0.39	62350.00	0.00	0.015
AB1	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
AB2	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
AB3	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
AB4	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
BB	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
BB1	4	1	0.79	4	1	0.79	2	2	0.79	62350.00	0.00	0.060
A1	4	1	0.75	4	1	0.75	2	5	0.75	64960.00	105995.00	0.022

A2	4	1	0.75	4	1	0.75	2	5	0.75	64960.00	105995.00	0.022
No.1	2	1	0.63	2	1	0.63	0	0	0.63	59015.00	95555.00	0.010
BG-1	3	1	0.77	3	1	0.77	2	1	0.77	66055.56	95700.00	0.020
BG-4	4	1	0.77	4	1	0.77	2	2	0.77	66062.00	95700.00	0.029
C10-05N	2	1	0.63	2	1	0.63	0	0	0.63	84977.88	107222.09	0.019
C10-05S	2	1	0.63	2	1	0.63	0	0	0.63	84977.88	107222.09	0.019
C5-20N	2	1	0.63	2	1	0.63	0	0	0.63	84977.88	107222.09	0.019
C5-20S	2	1	0.63	2	1	0.63	0	0	0.63	85122.88	107367.09	0.019
10-2-3N	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
10-2-3S	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
10-3-3N	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
10-3-3S	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
10-3-2.25N	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
10-3-2.25S	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
20-3-3N	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
20-3-3S	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
10-2-2.25N	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
10-2-2.25S	2	1	0.75	2	1	0.75	0	0	0.75	65682.93	93175.79	0.025
10-1-2.25N	2	1	0.75	2	1	0.75	0	0	0.75	65685.00	93177.00	0.025
10-1-2.25S	2	1	0.75	2	1	0.75	0	0	0.75	65685.00	93177.00	0.025
D1N30	4	1	0.50	4	1	0.50	2	2	0.50	66845.00	91973.50	0.024
Test 1	6	1	0.50	6	1	0.50	2	4	0.50	52635.00	0.00	0.016
Test 2	6	1	0.50	6	1	0.50	2	4	0.50	52635.00	0.00	0.016
Test 3	6	1	0.50	6	1	0.50	2	4	0.50	52635.00	0.00	0.016
Test 4	6	1	0.50	6	1	0.50	2	4	0.50	52635.00	0.00	0.016
Test 5	6	1	0.50	6	1	0.50	2	4	0.50	52635.00	0.00	0.016
Test 6	6	1	0.50	6	1	0.50	2	4	0.50	52635.00	0.00	0.016
2D16RS	2	1	0.63	2	1	0.63	0	0	0.63	53505.00	0.00	0.020
4D13RS	4	1	0.51	4	1	0.51	0	0	0.51	53650.00	0.00	0.027
1007	2	1	0.24	2	1	0.24	0	0	0.24	48720.00	54955.00	0.018
WI_40_048E	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_40_048W	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_25_033_E	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024

WI_25_033_W	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_0_048W	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_40_067_E	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_40_067_W	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
2CLH18	3	1	1.00	3	1	1.00	2	1	1.00	47995.00	71920.00	0.019
2CMH18	3	1	1.00	3	1	1.00	2	1	1.00	47995.00	71920.00	0.019
2SLH18	3	1	1.00	3	1	1.00	2	1	1.00	47995.00	71920.00	0.019
3SMD12	3	1	1.25	3	1	1.25	2	1	1.25	47995.00	71920.00	0.030
HC4-8L16-T6-0.1P	3	1	0.63	3	1	0.63	2	1	0.63	73950.00	0.00	0.025
HC4-8L16-T6-0.2P	3	1	0.63	3	1	0.63	2	1	0.63	73950.00	0.00	0.025
Specimen_1	3	1	1.13	3	1	1.13	2	1	1.13	62988.00	93525.00	0.025
Specimen_2	3	1	1.13	3	1	1.13	2	1	1.13	62988.00	93525.00	0.025
Specimen_4	3	1	1.13	3	1	1.13	2	1	1.13	62988.00	93525.00	0.025
I_03	2	1	0.75	2	1	0.75	2	6	0.75	46835.00	70252.50	0.014
I_04	4	1	0.75	4	1	0.75	2	6	0.75	46835.00	70252.50	0.018
I_10	11	1	0.51	11	1	0.51	2	9	0.51	46835.00	70252.50	0.021
I_14	11	1	0.51	11	1	0.51	2	9	0.51	46835.00	70252.50	0.021
I_16	11	1	0.51	11	1	0.51	2	9	0.51	46835.00	70252.50	0.021
I_17	11	1	0.51	11	1	0.51	2	9	0.51	46835.00	70252.50	0.021
I_20	11	1	0.51	11	1	0.51	2	9	0.51	46835.00	70252.50	0.021
IK_43	3	1	0.51	3	1	0.51	0	0	0.51	63003.95	94505.93	0.020
IK_44	3	1	0.51	3	1	0.51	0	0	0.51	63003.95	94505.93	0.020
IK_45	3	1	0.51	3	1	0.51	0	0	0.51	63003.95	94505.93	0.020
IK_46	3	1	0.51	3	1	0.51	2	1	0.51	63003.95	94505.93	0.027
IK_62	5	1	0.39	5	1	0.39	0	0	0.39	50003.25	75004.88	0.020
IK_63	5	1	0.39	5	1	0.39	0	0	0.39	50003.25	75004.88	0.020
IK_64	5	1	0.39	5	1	0.39	0	0	0.39	50003.25	75004.88	0.020
UM_205	3	1	0.51	3	1	0.51	0	0	0.51	67004.50	100506.75	0.020
UM_214	3	1	0.51	3	1	0.51	0	0	0.51	67004.50	100506.75	0.020
UM_220	3	1	0.39	3	1	0.39	0	0	0.39	55004.30	82506.45	0.012
UM_231	3	1	0.35	3	1	0.35	0	0	0.35	47003.20	70504.80	0.010

UM_232	3	1	0.35	3	1	0.35	0	0	0.35	47003.20	70504.80	0.010
UM_233	3	1	0.39	3	1	0.39	0	0	0.39	54003.80	81005.70	0.012
UM_234	3	1	0.39	3	1	0.39	0	0	0.39	54003.80	81005.70	0.012
KO_372	2	1	0.51	2	1	0.51	0	0	0.51	76004.65	114006.98	0.013
KO_373	2	1	0.63	2	1	0.63	0	0	0.63	76004.65	114006.98	0.020
KO_452	2	1	0.75	2	1	0.63	0	0	0.00	52002.80	78004.20	0.028
KO_454	2	1	0.87	2	1	0.63	0	0	0.00	52002.80	78004.20	0.038
Specimen1	3	1	0.50	3	1	0.50	2	1	0.50	69455.00	99905.00	0.019
Specimen2	3	1	0.50	3	1	0.50	2	1	0.50	69455.00	99905.00	0.019
U2	3	1	0.98	3	1	0.98	2	1	0.98	65685.00	98527.50	0.032
H-2-1_3	3	1	0.51	3	1	0.51	2	1	0.51	52459.55	76726.75	0.027
H-2-1_5	3	1	0.51	3	1	0.51	2	1	0.51	52459.55	76726.75	0.027
HT-2-1_3	3	1	0.51	3	1	0.51	2	1	0.51	52459.55	76726.75	0.027
HT-2-1_5	3	1	0.51	3	1	0.51	2	1	0.51	52459.55	76726.75	0.027
3CMD12	3	1	1.25	3	1	1.25	2	1	1.25	47995.00	71920.00	0.030
Unit_6	4	1	0.51	4	1	0.51	2	2	0.51	59305.00	88957.50	0.018
SRC	4	1	0.77	4	1	0.77	2	2	0.77	58000.00	87000.00	0.015
A4	4	1	0.63	4	1	0.63	2	2	0.63	55114.50	82671.75	0.027
FS0	4	1	0.75	4	1	0.75	2	2	0.75	56115.00	84172.50	0.038
FS1	4	1	0.75	4	1	0.75	2	2	0.75	56115.00	84172.50	0.038
CUW	2	1	0.75	2	1	0.75	2	3	0.75	63945.00	95917.50	0.03
I18	11	1	0.51	11	1	0.51	2	9	0.51	46835.00	70252.50	0.02
I21	11	1	0.51	11	1	0.51	2	9	0.51	46835.00	70252.50	0.02
C1	4	1	0.50	4	1	0.50	2	2	0.50	49300.00	73950.00	0.02
C4	4	1	0.50	4	1	0.50	2	2	0.50	49300.00	73950.00	0.02
C8	4	1	0.50	4	1	0.50	2	2	0.50	49300.00	73950.00	0.02
C12	4	1	0.50	4	1	0.50	2	2	0.50	49300.00	73950.00	0.02
D1	4	1	0.50	4	1	0.50	2	2	0.50	64815.00	97222.50	0.02
D13	5	1	0.50	5	1	0.50	2	3	0.50	64815.00	97222.50	0.02
D14	5	1	0.50	5	1	0.50	2	3	0.50	64815.00	97222.50	0.02
D16	4	1	0.50	4	1	0.50	2	2	0.50	64815.00	97222.50	0.02
WI_0_033E	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.02

Table A-2-7: Transverse reinforcement data of condition ii rectangular columns

	Transverse reinforcement details				**Transverse steel properties**				
Column designation	Bar dia. (in.)	No. of bars perpendicular to load	No. of bars parallel to load	s (in.)	f_{yt} (psi)	f_{ut} (psi)	Vol. ρ_t	ρ''	s/d
No. 4	0.24	4	4	3.70	36975.00	58290.00	0.006	0.003	0.25
BL-1	0.24	4	4	1.38	47618.00	0.00	0.016	0.016	0.20
B1	0.20	4	4	2.36	112230.00	124265.00	0.005	0.005	0.28
B3	0.22	4	4	2.36	49880.00	55245.00	0.006	0.006	0.28
B6	0.20	4	4	2.36	124265.00	135430.00	0.005	0.005	0.28
B7	0.20	2	2	1.18	112230.00	124265.00	0.005	0.005	0.15
No.2S1	0.37	2	2	5.00	52635.00	77575.00	0.009	0.004	0.50
No.4S1	0.37	2	2	5.00	52635.00	77575.00	0.009	0.004	0.50
No.6S1	0.37	2	2	5.00	56840.00	76850.00	0.009	0.004	0.50
No.10	0.37	2	2	5.00	56840.00	76850.00	0.009	0.004	0.50
No.12	0.37	2	2	5.00	54085.00	71340.00	0.009	0.004	0.50
U1	0.39	2	2	5.91	68150.00	0.00	0.009	0.003	0.49
U3	0.39	2	2	2.95	68150.00	0.00	0.025	0.006	0.25
AA1	0.32	4	4	5.91	62350.00	0.00	0.012	0.005	0.72
AA2	0.31	4	4	5.91	62350.00	0.00	0.012	0.005	0.72
AA3	0.32	4	4	5.91	62350.00	0.00	0.012	0.005	0.72
AA4	0.32	4	4	5.91	62350.00	0.00	0.012	0.005	0.72
AB1	0.31	4	4	5.91	62350.00	0.00	0.012	0.005	0.74
AB2	0.31	4	4	5.91	62350.00	0.00	0.012	0.005	0.74
AB3	0.31	4	4	5.91	62350.00	0.00	0.012	0.005	0.74
AB4	0.31	4	4	5.91	62350.00	0.00	0.012	0.005	0.74
BB	0.31	4	4	3.94	62350.00	0.00	0.018	0.008	0.50
BB1	0.31	4	4	3.94	62350.00	0.00	0.018	0.008	0.50
A1	0.24	4	4	4.33	62060.00	107010.00	0.004	0.003	0.19
A2	0.24	4	4	4.33	62060.00	107010.00	0.004	0.003	0.19
No.1	0.25	2	2	9.00	50895.00	56550.00	0.022	0.001	0.95
BG-1	0.38	3	3	5.98	82650.00	98600.00	0.010	0.004	0.50
BG-4	0.37	4	4	5.98	82650.00	98600.00	0.013	0.005	0.50
C10-05N	0.37	2	2	3.00	58984.65	92725.86	0.010	0.009	0.52
C10-05S	0.37	2	2	3.00	58984.65	92725.86	0.010	0.009	0.52
C5-20N	0.37	2	2	3.00	58984.65	92725.86	0.010	0.009	0.52
C5-20S	0.37	2	2	3.04	59129.65	92870.86	0.010	0.009	0.53
10-2-3N	0.25	2	2	3.00	59580.50	76386.00	0.006	0.005	0.29
10-2-3S	0.25	2	2	3.00	59580.50	76386.00	0.006	0.005	0.29
10-3-3N	0.25	2	2	3.00	59580.50	76386.00	0.020	0.005	0.29
10-3-3S	0.25	2	2	3.00	59580.50	76386.00	0.020	0.005	0.29
10-3-2.25N	0.25	2	2	2.25	59580.50	76386.00	0.020	0.007	0.22
10-3-2.25S	0.25	2	2	2.25	59580.50	76386.00	0.020	0.007	0.22
20-3-3N	0.25	2	2	3.00	59580.50	76386.00	0.020	0.005	0.29
20-3-3S	0.25	2	2	3.00	59580.50	76386.00	0.020	0.005	0.29
10-2-2.25N	0.25	2	2	2.25	59580.50	76386.00	0.020	0.007	0.22

10-2-2.25S	0.25	2	2	2.25	59580.50	76386.00	0.020	0.007	0.22
10-1-2.25N	0.25	2	2	2.25	59580.50	76386.00	0.020	0.007	0.22
10-1-2.25S	0.25	2	2	2.25	59580.50	76386.00	0.020	0.007	0.22
D1N30	0.16	4	4	1.57	70325.00	87884.50	0.019	0.005	0.18
Test 1	0.24	2	2	2.76	53360.00	0.00	0.013	0.002	0.19
Test 2	0.24	2	2	2.76	53360.00	0.00	0.013	0.002	0.19
Test 3	0.24	2	2	2.76	53360.00	0.00	0.013	0.002	0.19
Test 4	0.24	2	2	2.76	53360.00	0.00	0.013	0.002	0.19
Test 5	0.24	2	2	2.76	53360.00	0.00	0.013	0.002	0.19
Test 6	0.24	2	2	2.76	53360.00	0.00	0.013	0.002	0.19
2D16RS	0.22	2	2	1.97	45820.00	0.00	0.006	0.005	0.28
4D13RS	0.22	2	2	1.97	45820.00	0.00	0.006	0.005	0.28
1007	0.16	2	2	3.15	49445.00	64960.00	0.005	0.004	1.27
WI_40_048E	0.25	2	2	3.50	50025.00	79895.00	0.005	0.005	0.35
WI_40_048W	0.25	2	2	3.50	50025.00	79895.00	0.005	0.005	0.35
WI_25_033_E	0.25	2	2	5.00	50025.00	79895.00	0.003	0.003	0.50
WI_25_033_W	0.25	2	2	5.00	50025.00	79895.00	0.003	0.003	0.50
WI_0_048W	0.25	2	2	3.50	50025.00	79895.00	0.005	0.005	0.35
WI_40_067_E	0.25	2	2	2.52	50025.00	79895.00	0.007	0.006	0.25
WI_40_067_W	0.25	2	2	2.52	50025.00	79895.00	0.007	0.006	0.25
2CLH18	0.37	2	2	18.00	57985.50	80910.00	0.002	0.001	1.15
2CMH18	0.37	2	2	18.00	57985.50	80910.00	0.002	0.001	1.15
2SLH18	0.37	2	2	18.00	57985.50	80910.00	0.002	0.001	1.15
3SMD12	0.37	3.414	3.414	12.00	57985.50	80910.00	0.004	0.002	0.77
HC4-8L16-T6-0.1P	0.25	3	3	2.01	65105.00	0.00	0.016	0.007	0.23
HC4-8L16-T6-0.2P	0.25	3	3	2.01	65105.00	0.00	0.016	0.007	0.23
Specimen_1	0.37	3.414	3.414	12.00	69020.00	104980.00	0.002	0.002	0.78
Specimen_2	0.37	3.414	3.414	12.00	69020.00	104980.00	0.002	0.002	0.78
Specimen_4	0.37	3.414	3.414	12.00	69020.00	104980.00	0.002	0.002	0.78
I_03	0.35	4	4	7.83	37468.00	56202.00	0.006	0.002	0.60
I_04	0.35	4	4	7.83	37468.00	56202.00	0.006	0.002	0.60
I_10	0.35	4	4	10.00	37468.00	56202.00	0.005	0.002	0.57
I_14	0.35	4	4	10.00	37468.00	56202.00	0.005	0.002	0.57
I_16	0.35	4	4	10.00	37468.00	56202.00	0.005	0.002	0.57
I_17	0.35	4	4	10.00	37468.00	56202.00	0.005	0.002	0.57
I_20	0.35	4	4	10.00	37468.00	56202.00	0.005	0.002	0.57
IK_43	0.24	2	2	3.94	81005.27	121507.90	0.007	0.003	0.58
IK_44	0.24	2	2	3.94	81005.27	121507.90	0.007	0.003	0.58
IK_45	0.24	2	2	3.94	81005.27	121507.90	0.007	0.003	0.58
IK_46	0.24	2	2	3.94	81005.27	121507.90	0.007	0.003	0.58
IK_62	0.24	2	2	3.94	69004.49	103506.73	0.007	0.003	0.58
IK_63	0.24	2	2	3.94	69004.49	103506.73	0.007	0.003	0.58
IK_64	0.24	2	2	3.94	69004.49	103506.73	0.007	0.003	0.58
UM_205	0.24	2	2	3.94	47003.06	70504.58	0.006	0.003	0.56
UM_214	0.24	2	2	7.87	47003.06	70504.58	0.003	0.001	1.11
UM_220	0.16	2	2	4.72	94006.11	141009.17	0.002	0.001	0.67

UM_231	0.16	2	2	3.94	76004.94	114007.41	0.003	0.001	0.56
UM_232	0.16	2	2	3.94	76004.94	114007.41	0.003	0.001	0.56
UM_233	0.16	2	2	3.94	76004.94	114007.41	0.003	0.001	0.56
UM_234	0.16	2	2	3.94	76004.94	114007.41	0.003	0.001	0.56
KO_372	0.26	2	2	3.94	51003.32	76504.97	0.008	0.003	0.59
KO_373	0.26	2	2	3.94	51003.32	76504.97	0.008	0.003	0.59
KO_452	0.26	2	2	3.94	45802.89	132008.58	0.008	0.003	0.59
KO_454	0.26	2	2	3.94	45802.89	132008.58	0.008	0.003	0.59
Specimen1	0.19	3.414	3.414	5.98	104110.00	104110.00	0.004	0.002	0.77
Specimen2	0.19	3.414	3.414	5.98	104110.00	104110.00	0.004	0.002	0.77
U2	0.39	2	2	5.91	68150.00	102225.00	0.007	0.003	0.49
H-2-1_3	0.24	2	2	1.57	52843.80	69386.85	0.016	0.007	0.23
H-2-1_5	0.24	2	2	1.97	52843.80	69386.85	0.013	0.006	0.29
HT-2-1_3	0.24	3	3	2.36	52843.80	69386.85	0.016	0.007	0.34
HT-2-1_5	0.24	3	3	2.95	52843.80	69386.85	0.013	0.006	0.43
3CMD12	0.37	3.414	3.414	12.00	57985.50	80910.00	0.004	0.002	0.77
Unit_6	0.24	2	2	3.94	56840.00	85260.00	0.005	0.002	0.39
SRC	0.44	2	2	11.81	58000.00	87000.00	0.004	0.002	0.47
A4	0.24	2	2	2.76	57507.00	86260.50	0.007	0.003	0.27
FS0	0.37	2	2	2.95	51475.00	77212.50	0.015	0.006	0.29
FS1	0.37	2	2	2.95	51475.00	77212.50	0.015	0.006	0.29
CUW	0.24	4	2	3.50	60030.00	90045.00	0.003	0.002	0.47
I18	0.35	4	4	10.00	37468.00	56202.00	0.005	0.002	0.57
I21	0.35	4	4	10.00	37468.00	56202.00	0.005	0.002	0.57
C1	0.20	2	2	6.30	85115.00	127672.50	0.002	0.001	0.62
C4	0.25	2	2	2.95	85115.00	127672.50	0.007	0.003	0.29
C8	0.25	2	2	2.95	55680.00	83520.00	0.007	0.003	0.29
C12	0.25	2	2	2.95	55680.00	83520.00	0.007	0.003	0.29
D1	0.25	2	2	1.97	57710.00	86565.00	0.010	0.004	0.19
D13	0.25	2	2	1.97	57710.00	86565.00	0.010	0.004	0.19
D14	0.25	2	2	1.97	57710.00	86565.00	0.010	0.004	0.19
D16	0.25	2	2	1.97	57710.00	86565.00	0.010	0.004	0.19
WI_0_033E	0.25	2	2	5.00	50025.00	79895.00	0.003	0.003	0.50

Table A-2-8: Test configuration and modes of failure of condition ii rectangular columns

Column designation	Test configuration	Failure mode (based on column behavior)
No. 4	2	1
BL-1	2	1
B1	3	1
B3	3	1
B6	3	1
B7	3	1
No.2S1	2	1
No.4S1	2	1
No.6S1	2	1
No.10	2	1
No.12	2	1
U1	1	1
U3	1	1
AA1	2	1
AA2	2	1
AA3	2	1
AA4	2	1
AB1	2	1
AB2	2	1
AB3	2	1
AB4	2	1
BB	2	1
BB1	2	1
A1	2	1
A2	2	1
No.1	1	1
BG-1	1	1
BG-4	1	1
C10-05N	1	1
C10-05S	1	1
C5-20N	1	1
C5-20S	1	1
10-2-3N	3	1
10-2-3S	3	1
10-3-3N	3	1
10-3-3S	3	1
10-3-2.25N	3	1
10-3-2.25S	3	1
20-3-3N	3	1
20-3-3S	3	1
10-2-2.25N	3	1
10-2-2.25S	3	1
10-1-2.25N	3	1
10-1-2.25S	3	1
D1N30	1	1
Test 1	1	1
Test 2	1	1
Test 3	1	1
Test 4	1	1
Test 5	1	1
Test 6	1	1
2D16RS	3	2
4D13RS	3	2
1007	3	2
WI_40_048E	2	2
WI_40_048W	2	2
WI_25_033_E	2	2
WI_25_033_W	2	2
WI_0_048W	2	2
WI_40_067_E	2	2
WI_40_067_W	2	2
2CLH18	3	2
2CMH18	3	2
2SLH18	3	2
3SMD12	3	2
HC4-8L16-T6-0.1P	3	2
HC4-8L16-T6-0.2P	3	2
Specimen_1	3	2
Specimen_2	3	2
Specimen_4	3	2
I_03	1	2
I_04	1	2
I_10	1	2
I_14	1	2
I_16	1	2
I_17	1	2
I_20	1	2
IK_43	2	2
IK_44	2	2
IK_45	2	2
IK_46	2	2
IK_62	2	2
IK_63	2	2
IK_64	2	2

Column designation	Test configuration	Failure mode (based on column behavior)
UM_205	2	2
UM_214	2	2
UM_220	2	2
UM_231	2	2
UM_232	2	2
UM_233	2	2
UM_234	2	2
KO_372	2	2
KO_373	2	2
KO_452	2	2
KO_454	2	2
Specimen1	3	2
Specimen2	3	2
U2	1	2
H-2-1_3	3	2
H-2-1_5	3	2
HT-2-1_3	3	2
HT-2-1_5	3	2
3CMD12	3	2
Unit_6	3	2
SRC	1	2
A4	1	2
FS0	1	2
FS1	1	2
CUW	3	3
I18	1	3
I21	1	3
C1	3	3
C4	3	3
C8	3	3
C12	3	3
D1	3	3
D13	3	3
D14	3	3
D16	3	3
WI_0_033E	2	3

Table A-2-9: Reported and calculated data of condition iii rectangular columns

			Specimen dimensions							Axial load		Concrete properties		
Author	Column designation	Scale factor	h (in.)	b (in.)	d (in.)	d' (in.)	L (in.)	a (in.)	a/d	P (kips)	$\frac{P}{A_g f_c'}$	f_c' (psi)	E_c (psi)	f_r (psi)
Wight	WI_40_033aE	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	42.49	0.12	5031.50	4043184.82	532.00
Wight	WI_40_033aW	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	42.49	0.12	5031.50	4043184.82	532.00
Wight	WI_40_033_E	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	40.01	0.11	4872.00	3978583.67	523.50
Wight	WI_40_033_W	1	12.01	5.98	10.01	2.00	34.49	34.49	3.45	40.01	0.11	4872.00	3978583.67	523.50
Umemura & Endo	UM_207	0.1	7.87	7.87	7.09	0.79	15.75	15.75	2.22	35.28	0.22	2550.55	2878669.30	378.77
Yalcin	BR-S1	1	21.65	21.65	18.75	2.91	58.46	58.46	3.12	404.64	0.13	6525.00	4604315.91	605.83
Verma	UnitR1A	0.4	24.00	16.00	22.50	1.50	96.00	48.00	2.13	114.04	0.05	5499.85	4227175.49	556.21
Lynn	3CMH18	1	18.00	18.00	15.50	2.50	116.00	58.00	3.74	339.90	0.26	4002.00	3605897.67	474.46
Lynn	3SLH18	1	18.00	18.00	15.50	2.50	116.00	58.00	3.74	113.07	0.09	3900.50	3559877.03	468.40
Yoshimura	Unit_7	0.5	11.81	11.81	10.04	1.77	47.24	23.62	2.35	124.22	0.20	4451.50	3803015.05	500.40
Yarandi	RRC	1	27.56	13.78	25.15	2.40	59.06	59.06	2.35	290.89	0.15	5075.00	4060624.95	534.29
Pandey	C1	1	11.81	11.81	10.24	1.58	41.34	41.34	4.04	20.23	0.03	5278.00	4141041.17	544.87
Imai	UNIT_1	1	19.69	15.75	17.44	2.24	64.96	32.48	1.86	88.20	0.07	3929.50	3573086.27	470.14
Arakawa	OA2	1	7.09	7.09	6.29	0.80	17.72	8.86	1.41	42.75	0.18	4611.00	3870547.64	509.28
Arakawa	OA5	1	7.09	7.09	6.29	0.80	17.72	8.86	1.41	107.10	0.45	4785.00	3942900.58	518.80
Umehara	CUS	0.667	16.14	9.06	14.55	1.59	35.83	17.91	1.23	120.15	0.16	5060.50	4054819.91	533.53
Bett	UNIT_1_1	0.667	12.01	12.01	10.41	1.59	35.83	17.91	1.72	64.80	0.10	4335.50	3753137.29	493.83
Aboutaha	SC3	0.5	18.00	36.00	15.64	2.36	48.00	48.00	3.07	0.00	0.00	3175.50	3212039.77	422.64
Aboutaha	SC9	0.5	36.00	18.00	33.64	2.36	48.00	48.00	1.43	0.00	0.00	2320.00	2745483.56	361.25
Verma	UnitR3A	0.4	16.00	24.00	14.50	1.50	96.00	48.00	3.31	114.14	0.06	5001.05	4030931.83	530.39
Verma	UnitR5A	0.4	16.00	24.00	14.50	1.50	96.00	48.00	3.31	114.14	0.06	4700.90	3908097.25	514.22
Pandey	Specimen_B1	1	11.81	11.81	10.24	1.58	31.50	31.50	3.08	20.25	0.03	4718.30	3915323.32	515.17
Yoshimura	Specimen_CE	0.333	6.89	6.89	5.90	0.99	13.78	6.89	1.17	17.92	0.10	3770.00	3499818.57	460.50
Yoshimura	Specimen_BE	0.333	6.89	6.89	5.90	0.99	13.78	6.89	1.17	22.53	0.10	4741.50	3924937.39	516.44
Yoshimura	Specimen_LE	0.333	6.89	6.89	5.90	0.99	13.78	6.89	1.17	28.60	0.10	6017.50	4421635.16	581.79
Yoshimura	No.1	0.5	11.81	11.81	10.04	1.77	47.24	23.62	2.35	124.22	0.20	4451.50	3803015.05	500.40

Yoshimura	No.3	0.5	11.81	11.81	10.04	1.77	47.24	23.62	2.35	124.22	0.20	4451.50	3803015.05	500.40
Yoshimura	No.4	0.5	11.81	11.81	10.04	1.77	47.24	23.62	2.35	186.34	0.30	4451.50	3803015.05	500.40
Ousalem	D11	0.333	11.81	11.81	10.24	1.58	35.43	17.72	1.73	121.39	0.21	4081.75	3641648.77	479.16
Ousalem	D12	0.333	11.81	11.81	10.24	1.58	35.43	17.72	1.73	121.39	0.21	4081.75	3641648.77	479.16
Nakamura et al.	N-18M	1	11.81	11.81	10.04	1.77	35.43	17.72	1.76	96.51	0.18	3842.50	3533310.42	464.91
Nakamura et al.	N-27C	1	11.81	11.81	10.04	1.77	35.43	17.72	1.76	144.76	0.27	3842.50	3533310.42	464.91
Nakamura et al.	N-27M	1	11.81	11.81	10.04	1.77	35.43	17.72	1.76	144.76	0.27	3842.50	3533310.42	464.91
Yoshimura	S-1	1	15.75	15.75	13.78	1.97	35.43	35.43	2.57	180.56	0.20	3639.50	3438711.31	452.46
Lynn	3CLH18	1	18.00	18.00	15.50	2.50	116.00	58.00	3.74	113.07	0.09	3900.50	3559877.03	468.40
Pandey	A1	1	11.81	11.81	10.24	1.58	25.59	25.59	2.50	20.23	0.03	4170.20	3680893.89	484.33

Table A-2-10: Longitudinal reinforcement data of condition iii rectangular columns

	Longitudinal reinforcement details									Longitudinal steel properties		
	Tension face			Compression face			Middle layer					
Column designation	Number of bars perpendicular to load	Number of bars parallel to load	Bar dia (in.)	Number of bars perpendicular to load	Number of bars parallel to load	Bar dia. (in.)	Number of bars perpendicular to load	Number of bars parallel to load	Bar dia (in.)	f_{yl} (psi)	f_{ul} (psi)	ρ_l
WI_40_033aE	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_40_033aW	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_40_033_E	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
WI_40_033_W	2	1	0.75	2	1	0.75	0	0	0.75	71920.00	121075.00	0.024
UM_207	3	1	0.51	3	1	0.51	0	0	0.51	67004.50	100506.75	0.020
BR-S1	4	1	0.99	4	1	0.99	2	2	0.99	64525.00	95410.00	0.020
UnitR1A	5	1	0.75	5	1	0.75	2	6	0.75	47003.20	70504.80	0.025
3CMH18	3	1	1.25	3	1	1.25	2	1	1.25	47995.00	71920.00	0.030
3SLH18	3	1	1.25	3	1	1.25	2	1	1.25	47995.00	71920.00	0.030
Unit_7	4	1	0.51	4	1	0.51	2	2	0.51	59305.00	88957.50	0.018
RRC	4	1	0.77	4	1	0.77	2	2	0.77	58000.00	87000.00	0.015
C1	4	1	0.63	4	1	0.63	2	2	0.63	57478.00	86217.00	0.027
UNIT_1	5	1	0.87	5	1	0.87	2	2	0.87	46110.00	69165.00	0.027
OA2	3	1	0.50	3	1	0.50	2	1	0.50	49300.00	73950.00	0.031
OA5	3	1	0.50	3	1	0.50	2	1	0.50	49300.00	73950.00	0.031
CUS	2	1	0.75	2	1	0.75	2	3	0.75	63945.00	95917.50	0.030
UNIT_1_1	3	1	0.75	3	1	0.75	2	1	0.75	66990.00	100485.00	0.024
SC3	8	1	0.98	8	1	0.98	0	0	0.98	62930.00	94395.00	0.019
SC9	2	1	0.98	2	1	0.98	2	6	0.98	62930.00	94395.00	0.019
UnitR3A	5	1	0.75	5	1	0.75	2	6	0.75	68005.00	102007.50	0.025
UnitR5A	5	1	0.75	5	1	0.75	2	6	0.75	68005.00	102007.50	0.025
Specimen_B1	6	1	0.63	6	1	0.63	0	0	0.63	55114.50	82671.75	0.027

Specimen_CE	4	1	0.39	4	1	0.39	2	2	0.24	56260.00	82505.00	0.031
Specimen_BE	4	1	0.39	4	1	0.39	2	2	0.24	49880.00	72210.00	0.031
Specimen_LE	5	1	0.51	5	1	0.51	2	3	0.51	49880.00	72210.00	0.069
No.1	4	1	0.63	4	1	0.63	2	2	0.63	58290.00	87435.00	0.027
No.3	4	1	0.63	4	1	0.63	2	2	0.63	58290.00	87435.00	0.027
No.4	4	1	0.63	4	1	0.63	2	2	0.63	58290.00	87435.00	0.027
D11	5	1	0.50	5	1	0.50	2	3	0.50	64815.00	97222.50	0.023
D12	5	1	0.50	5	1	0.50	2	3	0.50	64815.00	97222.50	0.023
N-18M	4	1	0.63	4	1	0.63	2	2	0.63	55100.00	82650.00	0.027
N-27C	4	1	0.63	4	1	0.63	2	2	0.63	55100.00	82650.00	0.027
N-27M	4	1	0.63	4	1	0.63	2	2	0.63	55100.00	82650.00	0.027
S-1	5	1	0.87	5	1	0.87	2	3	0.87	79315.00	118972.50	0.039
3CLH18	3	1	1.25	3	1	1.25	2	1	1.25	47995.00	71920.00	0.030
A1	4	1	0.63	4	1	0.63	2	2	0.63	55114.50	82671.75	0.027

Table A-2-11: Transverse reinforcement data of condition iii rectangular columns

	Transverse reinforcement details				Transverse steel properties				
Column designation	Bar dia. (in.)	No. of bars perpendicular to load	No. of bars parallel to load	s (in.)	f_{yt} (psi)	f_{ut} (psi)	Vol. ρ_t	ρ''	s/d
WI_40_033aE	0.25	2	2	5.00	50025.00	79895.00	0.003	0.003	0.50
WI_40_033aW	0.25	2	2	5.00	50025.00	79895.00	0.003	0.003	0.50
WI_40_033_E	0.25	2	2	5.00	50025.00	79895.00	0.003	0.003	0.50
WI_40_033_W	0.25	2	2	5.00	50025.00	79895.00	0.003	0.003	0.50
UM_207	0.24	2	2	3.94	47003.06	70504.58	0.006	0.003	0.56
BR-S1	0.44	2	2	11.81	61625.00	92075.00	0.003	0.001	0.63
UnitR1A	0.25	2	2	5.00	52002.80	78004.20	0.002	0.001	0.22
3CMH18	0.37	2	2	18.00	57985.50	80910.00	0.002	0.001	1.16
3SLH18	0.37	2	2	18.00	57985.50	80910.00	0.002	0.001	1.16
Unit_7	0.24	2	2	5.91	56840.00	85260.00	0.003	0.001	0.59
RRC	0.25	2	2	11.81	58000.00	87000.00	0.001	0.001	0.47
C1	0.24	2	2	5.91	61871.50	92807.25	0.003	0.001	0.58
UNIT_1	0.35	2	2	3.94	48720.00	73080.00	0.004	0.003	0.23
OA2	0.16	2	2	2.53	36105.00	54157.50	0.002	0.002	0.40
OA5	0.16	2	2	2.53	36105.00	54157.50	0.002	0.002	0.40
CUS	0.24	2	4	3.50	60030.00	90045.00	0.003	0.006	0.24
UNIT_1_1	0.24	3.414	3.414	8.27	60030.00	90045.00	0.003	0.002	0.79
SC3	0.37	2	5	16.00	58000.00	90915.00	0.003	0.001	1.02
SC9	0.37	5	2	16.00	58000.00	90915.00	0.002	0.001	0.48
UnitR3A	0.25	2	2	5.00	47003.20	70504.80	0.002	0.001	0.34
UnitR5A	0.25	2	2	5.00	47003.20	70504.80	0.002	0.001	0.34
Specimen_B1	0.24	2	2	9.84	57507.00	86260.50	0.002	0.001	0.96
Specimen_CE	0.24	2	2	4.33	45240.00	71340.00	0.007	0.003	0.73
Specimen_BE	0.24	2	2	4.33	45240.00	71340.00	0.007	0.003	0.73
Specimen_LE	0.24	2	2	0.79	46690.00	61335.00	0.038	0.016	0.13
No.1	0.24	2	2	3.94	56840.00	85260.00	0.005	0.002	0.39
No.3	0.24	2	2	7.87	56840.00	85260.00	0.002	0.001	0.78
No.4	0.24	2	2	3.94	56840.00	85260.00	0.005	0.002	0.39
D11	0.25	2	2	5.91	57710.00	86565.00	0.003	0.001	0.58
D12	0.25	2	2	5.91	57710.00	86565.00	0.003	0.001	0.58
N-18M	0.25	2	2	3.94	55100.00	82650.00	0.005	0.002	0.39
N-27C	0.25	2	2	3.94	55100.00	82650.00	0.005	0.002	0.39
N-27M	0.25	2	2	3.94	55100.00	82650.00	0.005	0.002	0.39
S-1	0.37	2	2	7.09	51475.00	77212.50	0.004	0.002	0.51
3CLH18	0.37	2	2	18.00	57985.50	80910.00	0.002	0.001	1.16
A1	0.24	2	2	5.91	57507.00	86260.50	0.003	0.001	0.58

Table A-2-12: Test configurations and modes of failures of condition iii rectangular columns

Column designation	Test configuration	Failure mode (based on column behavior)
WI_40_033aE	2	2
WI_40_033aW	2	2
WI_40_033_E	2	2
WI_40_033_W	2	2
UM_207	2	2
BR-S1	1	2
UnitR1A	3	2
3CMH18	3	2
3SLH18	3	2
Unit_7	3	2
RRC	1	2
C1	1	2
UNIT_1	3	3
OA2	3	3
OA5	3	3
CUS	3	3
UNIT_1_1	3	3
SC3	1	3
SC9	1	3
UnitR3A	3	3
UnitR5A	3	3
Specimen_B1	1	3
Specimen_CE	3	3
Specimen_BE	3	3
Specimen_LE	3	3
No.1	3	3
No.3	3	3
No.4	3	3
D11	3	3
D12	3	3
N-18M	3	3
N-27C	3	3
N-27M	3	3
S-1	1	3
3CLH18	3	3
A1	1	3

Table A-2-13: Reported and calculated data of condition i circular columns

			Specimen dimensions						Axial load		Concrete properties		
Author	Column designation	Scale factor	h or b (in.)	d (in.)	d' (in.)	L (in.)	a (in.)	a/d	P (kips)	$\frac{P}{A_g f_c'}$	f_c' (psi)	E_c (psi)	f_r (psi)
Munro	No.1	1	19.69	15.75	1.31	107.48	107.48	6.83	5.93	0.00	5800.00	4340990.67	571.18
Ng	No. 2	1	9.84	7.87	0.77	52.76	52.76	6.70	3.80	0.01	5089.50	4066421.71	535.06
Ng	No.3	1	9.84	7.87	0.72	36.61	36.61	4.65	123.64	0.34	4785.00	3942900.58	518.80
Ang	No.2	1	15.75	12.60	1.22	62.99	62.99	5.00	474.55	0.59	4132.50	3664217.86	482.13
Potangaroa	No.5A	1	23.62	18.90	1.89	47.24	47.24	2.50	760.95	0.37	4712.50	3912916.11	514.86
Potangaroa	No.5B	1	23.62	18.90	1.89	47.24	47.24	2.50	1521.90	0.74	4712.50	3912916.11	514.86
Zahn et al.	No.5	1	15.75	12.60	1.22	62.99	62.99	5.00	124.76	0.14	4669.00	3894814.63	512.48
Zahn et al.	No.6	1	15.75	12.60	1.22	62.99	62.99	5.00	467.58	0.61	3915.00	3566487.77	469.27
Watson and Park	No.10	1	15.75	12.60	1.14	62.99	62.99	5.00	596.17	0.53	5800.00	4340990.67	571.18
Watson and Park	No.11	1	15.75	12.60	1.22	62.99	62.99	5.00	813.78	0.74	5655.00	4286384.84	564.00
Petrovski	M1E1	1	12.09	9.67	1.77	75.20	75.20	7.78	32.60	0.05	5626.00	4275379.98	562.55
Petrovski	M1E2	1	12.09	9.67	1.77	75.20	75.20	7.78	57.10	0.09	5249.00	4129649.02	543.37
Lim	Con1	0.20	5.98	4.79	0.72	44.88	44.88	9.38	33.94	0.24	5002.50	4031516.15	530.46
Lim	Con2	0.20	5.98	4.79	0.72	22.44	22.44	4.69	33.94	0.24	5002.50	4031516.15	530.46
Lim	Con3	0.20	5.98	4.79	0.72	22.44	22.44	4.69	49.46	0.35	5002.50	4031516.15	530.46
Cheok et al.	NIST, Full scale Flexure	1	59.84	47.87	3.47	359.84	359.84	7.52	1000.36	0.07	5191.00	4106769.90	540.36
Cheok et al.	NIST Ful sclae shear	1	59.84	47.87	3.35	179.92	179.92	3.76	1000.36	0.07	4973.50	4019813.62	528.92
Stone	NIST Model N1	1	9.84	7.87	0.59	29.53	29.53	3.75	26.98	0.10	3494.50	3369514.88	443.36
Stone	NIST Model N2	1	9.84	7.87	0.59	29.53	29.53	3.75	53.73	0.21	3349.50	3298867.31	434.06
Stone	NIST Model N3	1	9.84	7.87	0.57	59.06	59.06	7.50	26.98	0.10	3683.00	3459200.34	455.16
Stone	NIST Model N4	1	9.84	7.87	0.59	29.53	29.53	3.75	26.98	0.10	3538.00	3390422.10	446.11
Stone	NIST Model N5	1	9.84	7.87	0.59	29.53	29.53	3.75	53.73	0.20	3523.50	3383467.38	445.19
Stone	NIST Model N6	1	9.84	7.87	0.57	59.06	59.06	7.50	26.98	0.10	3378.50	3313117.34	435.94
Kenchiku Siryo	BRI No.2	1	9.84	7.87	1.94	29.53	14.76	1.88	41.36	0.14	3842.50	3533310.42	464.91

Kenchiku Siryo	BRI No.3 ws27bs	1	9.84	7.87	2.06	39.37	19.69	2.50	72.39	0.21	4582.00	3858356.90	507.68
Kunnath	A2	0.25	12.01	9.61	0.84	54.02	54.02	5.62	44.96	0.09	4205.00	3696220.37	486.34
Kunnath	A3	0.25	12.01	9.61	0.84	54.02	54.02	5.62	44.96	0.09	4205.00	3696220.37	486.34
Kunnath	A4	0.25	12.01	9.61	0.84	54.02	54.02	5.62	49.91	0.09	5147.50	4089526.56	538.10
Kunnath	A5	0.25	12.01	9.61	0.84	54.02	54.02	5.62	49.91	0.09	5147.50	4089526.56	538.10
Kunnath	A6	0.25	12.01	9.61	0.84	54.02	54.02	5.62	49.91	0.09	5147.50	4089526.56	538.10
Kunnath	A7	0.25	12.01	9.61	0.84	54.02	54.02	5.62	49.91	0.09	4756.00	3930934.24	517.23
Kunnath	A8	0.25	12.01	9.61	0.84	54.02	54.02	5.62	49.91	0.09	4756.00	3930934.24	517.23
Kunnath	A9	0.25	12.01	9.61	0.84	54.02	54.02	5.62	49.91	0.09	4712.50	3912916.11	514.86
Kunnath	A10	0.25	12.01	9.61	0.84	54.02	54.02	5.62	44.96	0.10	3915.00	3566487.77	469.27
Kunnath	A11	0.25	12.01	9.61	0.84	54.02	54.02	5.62	44.96	0.10	3915.00	3566487.77	469.27
Kunnath	A12	0.25	12.01	9.61	0.84	54.02	54.02	5.62	44.96	0.10	3915.00	3566487.77	469.27
Hose et al.	SRPH1	1	24.02	19.21	1.72	144.09	144.09	7.50	400.14	0.15	5959.50	4400274.48	578.98
Vu et al.	NH6	1	17.99	14.39	1.66	71.65	35.83	2.49	430.27	0.33	5075.00	4060624.95	534.29
Kowalsky	FL1	1	17.99	14.39	1.69	143.94	143.94	10.00	400.14	0.30	5307.00	4152402.08	546.37
Kowalsky	FL2	1	17.99	14.39	1.63	143.94	143.94	10.00	400.14	0.27	5800.00	4340990.67	571.18
Lehman et al	415	1	24.00	19.20	1.31	96.00	96.00	5.00	146.99	0.07	4495.00	3821551.39	502.84
Lehman et al	815	1	24.00	19.20	1.31	192.00	192.00	10.00	146.99	0.07	4495.00	3821551.39	502.84
Lehman et al	1015	1	24.00	19.20	1.31	240.00	240.00	12.50	146.99	0.07	4495.00	3821551.39	502.84
Lehman et al	407	1	24.00	19.20	1.31	96.00	96.00	5.00	146.99	0.07	4495.00	3821551.39	502.84
Lehman et al	430	1	24.00	19.20	1.31	96.00	96.00	5.00	146.99	0.07	4495.00	3821551.39	502.84
Calderone et al.	328	0.50	24.00	19.20	1.63	72.00	72.00	3.75	204.98	0.09	5002.50	4031516.15	530.46
Calderone et al.	828	0.50	24.00	19.20	1.63	192.00	192.00	10.00	204.98	0.09	5002.50	4031516.15	530.46
Calderone et al.	1028	0.50	24.00	19.20	1.63	240.00	240.00	12.50	204.98	0.09	5002.50	4031516.15	530.46
Sritharan et al. 1995	IC3	0.50	23.62	18.90	1.81	70.87	70.87	3.75	89.92	0.04	4785.00	3942900.58	518.80
Saatcioglu and Baingo	RC1	1	9.84	7.87	1.01	64.76	64.76	8.23	224.80	0.31	9425.00	5533699.03	728.12
Saatcioglu and Baingo	RC2	1	9.84	7.87	1.15	64.76	64.76	8.23	224.80	0.31	9425.00	5533699.03	728.12
Saatcioglu and Baingo	RC3	1	9.84	7.87	1.01	64.76	64.76	8.23	415.88	0.42	13050.00	6511486.01	856.77
Saatcioglu and Baingo	RC4	1	9.84	7.87	1.02	64.76	64.76	8.23	415.88	0.42	13050.00	6511486.01	856.77

Saatcioglu and Baingo	RC6	1	9.84	7.87	1.08	64.76	64.76	8.23	415.88	0.42	13050.00	6511486.01	856.77
Saatcioglu and Baingo	RC7	1	9.84	7.87	1.01	64.76	64.76	8.23	207.94	0.21	13050.00	6511486.01	856.77
Saatcioglu and Baingo	RC8	1	9.84	7.87	1.01	64.76	64.76	8.23	415.88	0.42	13050.00	6511486.01	856.77
Saatcioglu and Baingo	RC9	1	9.84	7.87	1.08	64.76	64.76	8.23	415.88	0.42	13050.00	6511486.01	856.77
Henry	415p	1	24.00	19.20	1.31	96.00	96.00	5.00	294.04	0.12	5394.00	4186299.80	550.83
Soderstrom	C1	1	16.50	13.20	2.81	77.50	77.50	5.87	0.00	0.00	8787.00	5343122.96	703.04
Soderstrom	C2	1	16.50	13.20	2.81	77.50	77.50	5.87	0.00	0.00	9077.00	5430577.59	714.55
Soderstrom	C3	1	16.50	13.20	2.83	77.50	77.50	5.87	0.00	0.00	10092.00	5726159.97	753.44
Soderstrom	C4	1	16.50	13.20	2.83	77.50	77.50	5.87	221.99	0.10	10092.00	5726159.97	753.44
Graff	C5	1	16.50	13.20	2.83	77.50	77.50	5.87	221.99	0.10	10092.00	5726159.97	753.44
Graff	C6	1	16.50	13.20	2.83	77.50	77.50	5.87	221.99	0.10	10092.00	5726159.97	753.44
Graff	C7	1	16.50	13.20	2.83	77.50	77.50	5.87	221.99	0.10	10092.00	5726159.97	753.44
Graff	C8	1	16.50	13.20	2.83	77.50	77.50	5.87	221.99	0.10	10092.00	5726159.97	753.44
Kowalsky and Moyer	1	1	18.00	14.40	1.06	96.00	96.00	6.67	52.00	0.04	4741.50	3924937.39	516.44
Kowalsky and Moyer	2	1	18.00	14.40	1.06	96.00	96.00	6.67	52.00	0.04	4959.00	4013949.55	528.15
Kowalsky and Moyer	3	1	18.00	14.40	1.06	96.00	96.00	6.67	52.00	0.04	4596.50	3864457.08	508.48
Kowalsky and Moyer	4	1	18.00	14.40	1.06	96.00	96.00	6.67	52.00	0.04	4915.50	3996305.73	525.83
Hamilton	UC1	1	16.00	12.80	0.93	73.00	73.00	5.70	0.00	0.00	5292.50	4146725.52	545.62
Hamilton	UC2	1	16.00	12.80	0.93	73.00	73.00	5.70	0.00	0.00	5292.50	4146725.52	545.62
Hamilton	UC3	1	16.00	12.80	0.93	73.00	73.00	5.70	0.00	0.00	5162.00	4095282.41	538.85
Potangaroa	Unit No.3 (Potangaroa)	1	23.62	18.90	1.65	47.24	47.24	2.50	966.64	0.57	3857.00	3539970.76	465.79
Petrovski	M2E1	1	12.09	9.67	1.77	35.43	35.43	3.66	32.60	0.05	5205.50	4112501.61	541.12
Petrovski	M2E2	1	12.09	9.67	1.77	35.24	35.24	3.64	57.10	0.10	4988.00	4025669.14	529.69
Kenchiku Kenkyu Siryo	ws21bs	1	9.84	7.87	1.94	19.69	9.84	1.25	72.39	0.25	3842.50	3533310.42	464.91
Kenchiku Kenkyu Siryo	ws25bs	1	9.84	7.87	1.94	19.69	9.84	1.25	36.19	0.12	3842.50	3533310.42	464.91

Table A-2-14: Longitudinal reinforcement data of condition i circular columns

	Longitudinal reinforcement details			Longitudinal steel properties		
Column designation	Bar dia. (in.)	No. of bars	θ	f_{yl} (psi)	f_{ul} (psi)	ρ_l
No.1	0.72	20	0	44225.00	59595.00	0.026
No. 2	0.51	10	0	44225.00	59595.00	0.026
No.3	0.47	10	0	42630.00	57420.00	0.022
No.2	0.63	16	0	44660.00	67425.00	0.024
No.5A	0.94	16	0	44515.00	60030.00	0.024
No.5B	0.94	16	0	44515.00	60030.00	0.024
No.5	0.63	16	0	48865.00	71195.00	0.024
No.6	0.63	16	0	48865.00	71195.00	0.024
No.10	0.63	12	0	68730.00	91828.50	0.018
No.11	0.63	12	0	68730.00	91828.50	0.018
M1E1	0.47	12	0	34800.00	0.00	0.018
M1E2	0.47	12	0	34800.00	0.00	0.018
Con1	0.50	8	0	64960.00	0.00	0.056
Con2	0.50	8	0	64960.00	0.00	0.056
Con3	0.50	8	0	64960.00	0.00	0.056
NIST, Full scale Flexure	1.69	25	0	68875.00	0.00	0.020
NIST Full scale shear	1.69	25	0	68875.00	0.00	0.020
NIST Model N1	0.28	25	0	64670.00	0.00	0.020
NIST Model N2	0.28	25	0	64670.00	0.00	0.020
NIST Model N3	0.28	25	0	64670.00	0.00	0.020
NIST Model N4	0.28	25	0	64670.00	0.00	0.020
NIST Model N5	0.28	25	0	64670.00	0.00	0.020
NIST Model N6	0.28	25	0	64670.00	0.00	0.020
BRI No.2	0.38	4	0	57855.00	0.00	0.005
BRI No.3 ws27bs	0.63	8	0	50025.00	0.00	0.025
A2	0.37	21	0	64960.00	100050.00	0.020
A3	0.37	21	0	64960.00	100050.00	0.020
A4	0.37	21	0	64960.00	100050.00	0.020
A5	0.37	21	0	64960.00	100050.00	0.020
A6	0.37	21	0	64960.00	100050.00	0.020
A7	0.37	21	0	64960.00	100050.00	0.020
A8	0.37	21	0	64960.00	100050.00	0.020
A9	0.37	21	0	64960.00	100050.00	0.020
A10	0.37	21	0	64960.00	100050.00	0.020
A11	0.37	21	0	64960.00	100050.00	0.020
A12	0.37	21	0	64960.00	100050.00	0.020
SRPH1	0.87	20	0	65975.00	108170.00	0.027

NH6	0.75	30	0	70499.00	0.00	0.052
FL1	0.63	30	0	69165.00	0.00	0.036
FL2	0.63	30	0	69165.00	0.00	0.036
415	0.63	22	0	66990.00	91350.00	0.015
815	0.63	22	0	66990.00	91350.00	0.015
1015	0.63	22	0	66990.00	91350.00	0.015
407	0.63	11	0	66990.00	91350.00	0.015
430	0.63	44	0	66990.00	91350.00	0.015
328	0.75	28	0	63988.50	87290.00	0.027
828	0.75	28	0	63988.50	87290.00	0.027
1028	0.75	28	0	63988.50	87290.00	0.027
IC3	0.87	14	0	62930.00	112375.00	0.019
RC1	0.63	8	0	60755.00	0.00	0.033
RC2	0.63	8	0	60755.00	0.00	0.033
RC3	0.63	8	0	60755.00	0.00	0.033
RC4	0.63	8	0	60755.00	0.00	0.033
RC6	0.63	8	0	60755.00	0.00	0.033
RC7	0.63	8	0	60755.00	0.00	0.033
RC8	0.63	8	0	60755.00	0.00	0.033
RC9	0.63	8	0	60755.00	0.00	0.033
415p	0.63	22	0	66990.00	0.00	0.015
C1	0.87	8	0	62277.50	103965.00	0.021
C2	0.87	8	0	62277.50	103965.00	0.021
C3	0.87	8	0	62277.50	103965.00	0.021
C4	0.87	8	0	62277.50	103965.00	0.021
C5	0.87	8	0	71282.00	118972.50	0.021
C6	0.87	8	0	73370.00	102979.00	0.021
C7	0.87	8	0	73370.00	102979.00	0.021
C8	0.87	8	0	71282.00	118972.50	0.021
1	0.75	12	0	81983.00	100978.00	0.020
2	0.75	12	0	81983.00	100978.00	0.020
3	0.75	12	0	81983.00	100978.00	0.020
4	0.75	12	0	81983.00	100978.00	0.020
UC1	0.50	12	0	66482.50	93670.00	0.012
UC2	0.50	12	0	66482.50	93670.00	0.012
UC3	0.50	12	0	66482.50	93670.00	0.012
Unit No.3 (Potangaroa)	0.94	16	0	43935.00	65902.50	0.024
M2E1	0.47	12	0	34800.00	52200.00	0.018
M2E2	0.47	12	0	34800.00	52200.00	0.018
ws21bs	0.37	8	0	54375.00	81562.50	0.009
ws25bs	0.50	8	0	55390.00	83085.00	0.016

Table A-2-15: Transverse reinforcement data of condition i circular columns

	Transverse reinforcement details				Transverse steel properties				
Column designation	Bar dia. (in.)	No. of bars perpendicular to load	No. of bars parallel to load	s (in.)	f_{yt} (psi)	f_{ut} (psi)	Vol. ρ_t	ρ''	s/d
No.1	0.31	2	2	1.34	56405.00	84607.50	0.013	0.006	0.09
No. 2	0.17	2	2	0.55	38135.00	57202.50	0.019	0.009	0.07
No.3	0.17	2	2	0.39	30015.00	45022.50	0.025	0.012	0.05
No.2	0.39	2	2	2.17	40600.00	60900.00	0.015	0.007	0.17
No.5A	0.63	2	2	2.17	40600.00	60900.00	0.026	0.012	0.11
No.5B	0.63	2	2	2.17	40600.00	60900.00	0.026	0.012	0.11
No.5	0.39	2	2	5.31	67570.00	101355.00	0.006	0.003	0.42
No.6	0.39	2	2	2.95	67570.00	101355.00	0.011	0.005	0.23
No.10	0.31	2	2	3.31	53940.00	80910.00	0.006	0.003	0.26
No.11	0.39	2	2	2.24	49010.00	73515.00	0.015	0.007	0.18
M1E1	0.24	2	2	2.95	34800.00	52200.00	0.006	0.002	0.31
M1E2	0.24	2	2	2.95	34800.00	52200.00	0.006	0.002	0.31
Con1	0.15	2	2	0.87	89900.00	134850.00	0.015	0.006	0.18
Con2	0.15	2	2	0.87	89900.00	134850.00	0.015	0.006	0.18
Con3	0.15	2	2	0.87	89900.00	134850.00	0.015	0.006	0.18
NIST, Full scale Flexure	0.63	2	2	3.50	71485.00	107227.50	0.006	0.003	0.07
NIST Full scale shear	0.75	2	2	2.13	63075.00	94612.50	0.015	0.007	0.04
NIST Model N1	0.12	2	2	0.35	63945.00	95917.50	0.014	0.007	0.05
NIST Model N2	0.12	2	2	0.35	63945.00	95917.50	0.014	0.007	0.05
NIST Model N3	0.11	2	2	0.55	69020.00	103530.00	0.007	0.003	0.07
NIST Model N4	0.12	2	2	0.35	63945.00	95917.50	0.014	0.007	0.05
NIST Model N5	0.12	2	2	0.35	63945.00	95917.50	0.014	0.007	0.05
NIST Model N6	0.11	2	2	0.55	63945.00	95917.50	0.014	0.003	0.07
BRI No.2	0.35	2	2	1.97	51475.00	77212.50	0.028	0.010	0.25
BRI No.3 ws27bs	0.35	2	2	1.65	48502.50	72753.75	0.034	0.012	0.21
A2	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08
A3	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08
A4	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08
A5	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08
A6	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08
A7	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08
A8	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08

A9	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08
A10	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08
A11	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08
A12	0.16	2	2	0.75	62930.00	94395.00	0.009	0.004	0.08
SRPH1	0.37	2	2	2.24	60030.00	90045.00	0.009	0.004	0.12
NH6	0.50	2	2	1.57	62988.00	94482.00	0.030	0.014	0.11
FL1	0.37	2	2	2.99	64525.00	96787.50	0.009	0.004	0.21
FL2	0.25	2	2	2.01	63365.00	95047.50	0.006	0.003	0.14
415	0.25	2	2	1.25	87986.00	131979.00	0.007	0.003	0.07
815	0.25	2	2	1.25	87986.00	131979.00	0.007	0.003	0.07
1015	0.25	2	2	1.25	87986.00	131979.00	0.007	0.003	0.07
407	0.25	2	2	1.25	87986.00	131979.00	0.007	0.003	0.07
430	0.25	2	2	1.25	87986.00	131979.00	0.007	0.003	0.07
328	0.25	2	2	1.00	87986.00	131979.00	0.009	0.004	0.05
828	0.25	2	2	1.00	87986.00	131979.00	0.009	0.004	0.05
1028	0.25	2	2	1.00	87986.00	131979.00	0.009	0.004	0.05
IC3	0.37	2	2	2.52	62930.00	94395.00	0.008	0.004	0.13
RC1	0.30	2	2	1.97	145000.00	217500.00	0.015	0.007	0.25
RC2	0.44	2	2	1.97	60900.00	91350.00	0.035	0.016	0.25
RC3	0.30	2	2	1.97	145000.00	217500.00	0.015	0.007	0.25
RC4	0.31	2	2	1.97	84100.00	126150.00	0.018	0.008	0.25
RC6	0.30	2	2	3.94	60900.00	91350.00	0.017	0.004	0.50
RC7	0.30	2	2	1.97	145000.00	217500.00	0.015	0.007	0.25
RC8	0.30	2	2	1.97	145000.00	217500.00	0.015	0.007	0.25
RC9	0.44	2	2	1.97	60900.00	91350.00	0.034	0.016	0.25
415p	0.25	2	2	1.25	87986.00	131979.00	0.007	0.003	0.07
C1	0.37	2	2	2.00	59986.50	89979.75	0.018	0.007	0.15
C2	0.37	2	2	2.00	59986.50	89979.75	0.018	0.007	0.15
C3	0.39	2	2	2.00	59986.50	89979.75	0.019	0.007	0.15
C4	0.39	2	2	2.00	59986.50	89979.75	0.019	0.007	0.15
C5	0.39	2	2	2.00	59986.50	89979.75	0.019	0.007	0.15
C6	0.39	2	2	2.00	59986.50	89979.75	0.019	0.007	0.15
C7	0.39	2	2	2.00	59986.50	89979.75	0.019	0.007	0.15
C8	0.39	2	2	2.00	59986.50	89979.75	0.019	0.007	0.15
1	0.37	2	2	3.00	62988.00	94482.00	0.009	0.004	0.21
2	0.37	2	2	3.00	62988.00	94482.00	0.009	0.004	0.21
3	0.37	2	2	3.00	62988.00	94482.00	0.009	0.004	0.21
4	0.37	2	2	3.00	62988.00	94482.00	0.009	0.004	0.21
UC1	0.18	2	2	1.25	100267.50	150401.25	0.005	0.002	0.10
UC2	0.18	2	2	1.25	100267.50	150401.25	0.005	0.002	0.10
UC3	0.18	2	2	1.25	100267.50	150401.25	0.005	0.002	0.10
Unit No.3 (Potangaroa)	0.39	2	2	1.97	43500.00	65250.00	0.011	0.005	0.10
M2E1	0.24	2	2	1.42	34800.00	52200.00	0.006	0.005	0.15
M2E2	0.24	2	2	1.42	34800.00	52200.00	0.006	0.005	0.15
ws21bs	0.35	2	2	1.30	48502.50	72753.75	0.043	0.015	0.17
ws25bs	0.35	2	2	1.81	48502.50	72753.75	0.031	0.011	0.23

Table A-2-16: Test configurations and modes of failures of condition i circular columns

Column designation	Test configuration	Failure mode (based on column behavior)
No.1	1	1
No. 2	1	1
No.3	1	1
No.2	1	1
No.5A	1	1
No.5B	1	1
No.5	2	1
No.6	2	1
No.10	2	1
No.11	2	1
M1E1	1	1
M1E2	1	1
Con1	1	1
Con2	1	1
Con3	1	1
NIST, Full scale Flexure	1	1
NIST Ful sclae shear	1	1
NIST Model N1	1	1
NIST Model N2	1	1
NIST Model N3	1	1
NIST Model N4	1	1
NIST Model N5	1	1
NIST Model N6	1	1
BRI No.2	3	1
BRI No.3 ws27bs	3	1
A2	1	1
A3	1	1
A4	1	1
A5	1	1
A6	1	1
A7	1	1
A8	1	1
A9	1	1
A10	1	1
A11	1	1
A12	1	1
SRPH1	1	1
NH6	3	1
FL1	1	1

Column designation	Test configuration	Failure mode (based on column behavior)
FL2	1	1
415	1	1
815	1	1
1015	1	1
407	1	1
430	1	1
328	1	1
828	1	1
1028	1	1
IC3	1	1
RC1	1	1
RC2	1	1
RC3	1	1
RC4	1	1
RC6	1	1
RC7	1	1
RC8	1	1
RC9	1	1
415p	1	1
C1	1	1
C2	1	1
C3	1	1
C4	1	1
C5	1	1
C6	1	1
C7	1	1
C8	1	1
1	1	1
2	1	1
3	1	1
4	1	1
UC1	1	1
UC2	1	1
UC3	1	1
Unit No.3 (Potangaroa)	2	2
M2E1	1	2
M2E2	1	2
ws21bs	3	2
ws25bs	3	2

Table A-2-17: Reported and calculated data of condition ii circular columns

			Specimen dimensions						Axial load		Concrete properties		
Author	Column designation	Scale factor	*h* or *b* (in.)	*d* (in.)	*d'* (in.)	*L* (in.)	*a* (in.)	*a/d*	*P* (kips)	$\frac{P}{A_g f_c'}$	f_c' (psi)	E_c (psi)	f_r (psi)
Davey	No. 1	1	19.69	15.75	1.29	78.74	78.74	5.00	85.42	0.06	4814.00	3954830.72	520.37
Davey	No. 2	1	19.69	15.75	1.29	78.74	78.74	5.00	85.42	0.06	5046.00	4049006.54	532.76
Davey	No.3	1	19.69	15.75	1.29	78.74	78.74	5.00	85.42	0.06	4901.00	3990407.12	525.05
Ang	No.1	1	15.75	12.60	1.06	62.99	62.99	5.00	152.86	0.21	3770.00	3499818.57	460.50
Potangaroa	No.1	1	23.62	18.90	1.65	47.24	47.24	2.50	431.62	0.24	4118.00	3657783.76	481.29
Potangaroa	No.4	1	23.62	18.90	1.65	47.24	47.24	2.50	850.87	0.41	4770.50	3936921.96	518.02
Ang et al.	No.9	1	15.75	12.60	1.14	39.37	39.37	3.13	168.82	0.20	4335.50	3753137.29	493.83
Wong et al.	No.1	1	15.75	12.60	1.30	31.50	31.50	2.50	203.89	0.19	5510.00	4231074.33	556.72
Wong et al.	No.3	1	15.75	12.60	1.30	31.50	31.50	2.50	407.56	0.39	5365.00	4175031.14	549.35
Kenchiku Siryo	BRI No.3 ws22bs	1	9.84	7.87	1.80	39.37	19.69	2.50	72.39	0.21	4582.00	3858356.90	507.68
Arakawa	No.16	1	10.83	8.66	1.22	35.43	17.72	2.05	0.00	0.00	4538.50	3839998.24	505.26
Arakawa	No.20	1	10.83	8.66	1.22	35.43	17.72	2.05	48.33	0.12	4248.50	3715289.56	488.85
Vu et al.	NH1	1	17.99	14.39	1.48	71.65	35.83	2.49	433.41	0.31	5553.50	4247743.11	558.91
Vu et al.	NH3	1	17.99	14.39	1.48	71.65	35.83	2.49	218.06	0.15	5713.00	4308310.23	566.88
Kowalsky	FL3	1	17.99	14.39	1.63	143.94	143.94	10.00	400.14	0.28	5597.00	4264346.73	561.10
Sritharan et al. 1995	IC1	0.50	23.62	18.90	1.81	70.87	70.87	3.75	89.92	0.05	4553.00	3846127.53	506.07
Sritharan et al. 1995	B105IC2	0.50	23.62	18.90	1.81	70.87	70.87	3.75	89.92	0.04	5017.00	4037354.70	531.23
Nelson and Price	Col 1	1	20.00	16.00	1.24	60.00	60.00	3.75	325.96	0.13	8149.00	5145493.27	677.04
Nelson and Price	Col 2	1	20.00	16.00	1.24	60.00	60.00	3.75	279.43	0.11	8163.50	5150069.08	677.64
Nelson and Price	Col 3	1	20.00	16.00	1.24	60.00	60.00	3.75	256.05	0.10	8265.00	5181986.59	681.84
Nelson and Price	Col 4	1	20.00	16.00	1.24	60.00	60.00	3.75	256.05	0.11	7641.50	4982693.40	655.62
Henry	415s	1	24.00	19.20	1.31	96.00	96.00	5.00	147.02	0.06	5394.00	4186299.80	550.83
Chai	Test3	0.40	24.00	19.20	1.29	143.98	143.98	7.50	399.92	0.19	4727.00	3918931.36	515.65

Coffman	1	0.50	18.00	14.40	2.06	112.75	112.75	7.83	157.36	0.19	3190.00	3219364.84	423.60
Ang_Beng_Ghee	Unit No.8	0.33	15.75	12.60	1.14	31.50	31.50	2.50	162.08	0.20	4161.50	3677052.28	483.82
Ang_Beng_Ghee	Unit No.10	0.33	15.75	12.60	1.38	31.50	31.50	2.50	176.24	0.20	4524.00	3833859.15	504.46
Ang_Beng_Ghee	Unit No.15	0.33	15.75	12.60	1.14	31.50	31.50	2.50	0.00	0.00	5046.00	4049006.54	532.76
Kenchiku Kenkyu Siryo	ws26bs	1	9.84	7.87	1.78	39.37	19.69	2.50	36.19	0.10	4582.00	3858356.90	507.68
Arakawa	Unit No.23	1	15.75	12.60	1.22	31.50	31.50	2.50	48.33	0.05	4683.50	3900857.79	513.27
Priestley	NR 1	0.4	24.02	19.21	1.00	36.00	36.00	1.87	113.07	0.06	4350.00	3759408.20	494.66
Vu	NH2	1	17.99	14.39	1.48	71.65	35.83	2.49	142.52	0.10	5684.00	4297361.52	565.44
Vu	NH4	1	17.99	14.39	1.66	71.65	35.83	2.49	191.08	0.15	5075.00	4060624.95	534.29
Vu	NH5	1	17.99	14.39	1.48	71.65	35.83	2.49	110.15	0.08	5104.00	4072210.21	535.82
Hamilton	UC15	1	16.00	12.80	0.75	41.25	41.25	3.22	0.00	0.00	5133.00	4083762.60	537.34
Ranf	Specimen S1	0.33	20.00	16.00	1.06	60.00	60.00	3.75	165.62	0.10	5270.75	4138196.07	544.50
Ranf	Specimen S3	0.33	20.00	16.00	1.06	60.00	60.00	3.75	256.11	0.10	8150.45	5145951.03	677.10
Ranf	Specimen C2	0.33	20.00	16.00	1.06	60.00	60.00	3.75	259.57	0.10	8260.65	5180622.73	681.66
Ranf	Specimen C3R	0.33	20.00	16.00	1.06	60.00	60.00	3.75	240.07	0.10	7640.05	4982220.63	655.56
Omar	Specimen S3	0.28	10.00	8.00	1.90	40.00	20.00	2.50	17.00	0.06	3800.45	3513924.02	462.36

Table A-2-18: Longitudinal reinforcement data of condition ii circular columns

	Longitudinal reinforcement details			Longitudinal steel properties		
Column designation	Bar dia. (in.)	No. of bars	θ	f_{yl} (psi)	f_{ul} (psi)	ρ_l
No. 1	0.72	20	0	54085.00	81780.00	0.026
No. 2	0.72	20	0	53795.00	81490.00	0.026
No.3	0.72	20	0	54085.00	81635.00	0.026
No.1	0.63	16	0	44660.00	67425.00	0.024
No.1	0.94	16	0	43935.00	59305.00	0.024
No.4	0.94	16	0	43935.00	59305.00	0.024
No.9	0.63	20	0	64960.00	100485.00	0.032
No.1	0.63	20	0	61335.00	83665.00	0.032
No.3	0.63	20	0	68875.00	90625.00	0.032
BRI No.3 ws22bs	0.37	8	0	54375.00	0.00	0.009
No.16	0.63	12	0	52635.00	0.00	0.039
No.20	0.63	12	0	52635.00	0.00	0.039
NH1	0.63	20	0	61987.50	0.00	0.024
NH3	0.63	20	0	61987.50	0.00	0.024
FL3	0.63	30	0	69165.00	0.00	0.036
IC1	0.87	14	0	64960.00	107155.00	0.019
B105IC2	0.87	14	0	64960.00	107155.00	0.019
Col 1	0.63	10	0	65975.00	104907.50	0.010
Col 2	0.63	10	0	65975.00	104907.50	0.010
Col 3	0.63	10	0	65975.00	104907.50	0.010
Col 4	0.63	10	0	65975.00	104907.50	0.010
415s	0.63	22	0	66990.00	0.00	0.015
Test3	0.75	26	0	45689.50	72181.00	0.025
1	0.75	9	0	54955.00	0.00	0.016
Unit No.8	0.63	20	0	64960.00	97440.00	0.032
Unit No.10	0.63	20	0	64960.00	97440.00	0.032
Unit No.15	0.63	12	0	63220.00	94830.00	0.019
ws26bs	0.50	8	0	55390.00	83085.00	0.016
Unit No.23	0.63	12	15	63220.00	94830.00	0.039
NR 1	0.50	12	0	66990.00	100485.00	0.005
NH2	0.63	20	0	61987.50	92981.25	0.024
NH4	0.75	30	6	67889.00	101833.50	0.052
NH5	0.63	20	0	73587.50	110381.25	0.024
UC15	0.50	12	15	66482.50	99723.75	0.012
Specimen S1	0.63	10	0	65975.00	98962.50	0.010
Specimen S3	0.63	10	0	65975.00	98962.50	0.010
Specimen C2	0.63	10	0	65975.00	98962.50	0.010
Specimen C3R	0.63	10	0	65975.00	104980.00	0.010
Specimen S3	0.38	8	0	52102.85	78154.28	0.011

Table A-2-19: Transverse reinforcement data of condition ii circular columns

	Transverse reinforcement details				Transverse steel properties				
Column designation	Bar dia. (in.)	No. of bars perpendicular to load	No. of bars parallel to load	s (in.)	f_{yt} (psi)	f_{ut} (psi)	Vol. ρ_t	ρ''	s/d
No. 1	0.26	2	2	2.56	45240.00	67860.00	0.004	0.002	0.16
No. 2	0.26	2	2	2.56	45240.00	67860.00	0.004	0.002	0.16
No.3	0.26	2	2	2.56	49590.00	74385.00	0.004	0.002	0.16
No.1	0.23	2	2	1.57	44660.00	66990.00	0.008	0.003	0.13
No.1	0.39	2	2	2.95	43500.00	65250.00	0.008	0.003	0.16
No.4	0.39	2	2	2.76	61335.00	92002.50	0.008	0.004	0.15
No.9	0.24	2	2	1.18	53940.00	80910.00	0.010	0.005	0.09
No.1	0.39	2	2	2.36	43500.00	65250.00	0.014	0.007	0.19
No.3	0.39	2	2	2.36	43500.00	65250.00	0.014	0.007	0.19
BRI No.3 ws22bs	0.23	2	2	2.48	53070.00	79605.00	0.010	0.003	0.32
No.16	0.24	2	2	1.38	55245.00	82867.50	0.013	0.006	0.16
No.20	0.24	2	2	1.38	55245.00	82867.50	0.013	0.006	0.16
NH1	0.37	2	2	2.36	62379.00	93568.50	0.011	0.005	0.16
NH3	0.37	2	2	2.36	62379.00	93568.50	0.011	0.005	0.16
FL3	0.25	2	2	2.99	64525.00	96787.50	0.009	0.002	0.21
IC1	0.37	2	2	3.82	62495.00	93742.50	0.005	0.002	0.20
B105IC2	0.37	2	2	3.82	62495.00	93742.50	0.005	0.002	0.20
Col 1	0.18	2	2	4.02	65975.00	98962.50	0.001	0.001	0.25
Col 2	0.18	2	2	4.02	65975.00	98962.50	0.001	0.001	0.25
Col 3	0.18	2	2	4.02	65975.00	98962.50	0.001	0.001	0.25
Col 4	0.18	2	2	4.02	65975.00	98962.50	0.001	0.001	0.25
415s	0.25	2	2	2.50	87986.00	131979.00	0.004	0.002	0.13
Test3	0.25	2	2	5.00	50982.00	76473.00	0.002	0.001	0.26
1	0.37	2	2	12.01	54955.00	82432.50	0.002	0.001	0.83
Unit No.8	0.24	2	2	1.18	53940.00	80910.00	0.010	0.005	0.09
Unit No.10	0.47	2	2	4.72	48140.00	72210.00	0.010	0.005	0.38
Unit No.15	0.24	2	2	2.36	47270.00	70905.00	0.005	0.002	0.19
ws26bs	0.15	2	2	1.46	56042.50	84063.75	0.008	0.003	0.19
Unit No.23	0.47	2	2	6.30	48140.00	72210.00	0.008	0.004	0.50
NR 1	0.25	2	2	3.00	52345.00	78517.50	0.003	0.001	0.16
NH2	0.37	2	2	2.36	62379.00	93568.50	0.011	0.005	0.16
NH4	0.50	2	2	1.77	62988.00	94482.00	0.027	0.012	0.12
NH5	0.37	2	2	3.15	64989.00	97483.50	0.009	0.004	0.22
UC15	0.18	2	2	2.50	100267.50	150401.25	0.003	0.001	0.20
Specimen S1	0.18	2	2	4.00	60030.00	65975.00	0.002	0.001	0.25
Specimen S3	0.18	2	2	4.00	60030.00	65975.00	0.002	0.001	0.25
Specimen C2	0.18	2	2	4.00	60030.00	65975.00	0.002	0.001	0.25
Specimen C3R	0.18	2	2	4.00	60030.00	65975.00	0.002	0.001	0.25
Specimen S3	0.15	2	2	3.85	30502.20	45753.30	0.002	0.001	0.48

Table A-2-20: Test configurations and modes of failures of condition ii circular columns

Column designation	Test configuration	Failure mode (based on column behavior)
No. 1	1	1
No. 2	1	1
No.3	1	1
No.1	1	1
No.1	1	1
No.4	1	1
No.9	1	1
No.1	1	1
No.3	1	1
BRI No.3 ws22bs	3	1
No.16	3	1
No.20	3	1
NH1	3	1
NH3	3	1
FL3	1	1
IC1	1	1
B105IC2	1	1
Col 1	1	1
Col 2	1	1
Col 3	1	1
Col 4	1	1
415s	1	1
Test3	1	1
1	1	1
Unit No.8	1	2
Unit No.10	1	2
Unit No.15	1	2
ws26bs	3	2
Unit No.23	3	2
NR 1	1	2
NH2	3	2
NH4	3	2
NH5	3	2
UC15	1	2
Specimen S1	1	2
Specimen S3	1	2
Specimen C2	1	2
Specimen C3R	1	2
Specimen S3	3	3

Table A-2-21: Reported and extracted data of condition iii circular columns

			Specimen dimensions						Axial load		Concrete properties		
Author	Column designation	Scale factor	*h* or *b* (in.)	*d* (in.)	*d'* (in.)	*L* (in.)	*a* (in.)	*a/d*	*P* (kips)	Axial load ratio	f_c' (psi)	E_c (psi)	f_r (psi)
Arakawa	No.21	1	10.83	8.66	1.22	47.24	23.62	2.73	48.33	0.12	4422.50	3790607.14	498.76
Arakawa	No.26	1	10.83	8.66	1.22	47.24	23.62	2.73	96.66	0.23	4480.50	3815382.62	502.02
Ang_Beng_Ghee	Unit No.1	0.33	15.75	12.60	1.14	31.50	31.50	2.50	0.00	0.00	5437.50	4203146.14	553.05
Ang_Beng_Ghee	Unit No.2	0.33	15.75	12.60	1.14	31.50	31.50	2.50	0.00	0.00	5394.00	4186299.80	550.83
Ang_Beng_Ghee	Unit No.3	0.33	15.75	12.60	1.14	39.37	39.37	3.13	0.00	0.00	5220.00	4118225.35	541.87
Ang_Beng_Ghee	Unit No.5	0.33	15.75	12.60	1.14	31.50	31.50	2.50	0.00	0.00	4509.50	3827710.22	503.65
Ang_Beng_Ghee	Unit No.11	0.33	15.75	12.60	1.14	31.50	31.50	2.50	168.82	0.20	4335.50	3753137.29	493.83
Ang_Beng_Ghee	Unit No.12	0.33	15.75	12.60	1.14	23.62	23.62	1.87	80.70	0.10	4147.00	3670640.68	482.98
Ang_Beng_Ghee	Unit No.13	0.33	15.75	12.60	1.14	31.50	31.50	2.50	102.28	0.10	5249.00	4129649.02	543.37
Ang_Beng_Ghee	Unit No.14	0.33	15.75	12.60	1.14	31.50	31.50	2.50	0.00	0.00	4886.50	3984499.78	524.28
Ang_Beng_Ghee	Unit No.17	0.33	15.75	12.60	1.14	39.37	39.37	3.13	96.89	0.10	4973.50	4019813.62	528.92
Ang_Beng_Ghee	Unit No.23	0.33	15.75	12.60	1.38	31.50	31.50	2.50	0.00	0.00	4683.50	3900857.79	513.27
Ang_Beng_Ghee	Unit No.24	0.33	15.75	12.60	1.30	31.50	31.50	2.50	0.00	0.00	4799.50	3948870.15	519.59
Wong	Unit No.2 (Wong)	1	15.75	12.60	1.14	31.50	31.50	2.50	411.38	0.39	5365.00	4175031.14	549.35
Arakawa	Unit No.10	1	10.83	8.66	1.22	23.62	11.81	1.36	48.33	0.12	4379.00	3771918.74	496.31
Arakawa	Unit No.15	1	10.83	8.66	1.22	35.43	17.72	2.05	0.00	0.00	4640.00	3882700.09	510.88
Priestley	NR2	0.4	24.02	19.21	1.00	36.00	36.00	1.87	113.07	0.06	4350.00	3759408.20	494.66
Hamilton	UC13	1	16.00	12.80	0.75	41.25	41.25	3.22	0.00	0.00	5031.50	4043184.82	532.00
Hamilton	UC14	1	16.00	12.80	0.75	41.25	41.25	3.22	0.00	0.00	5031.50	4043184.82	532.00
Chai	CCS1	0.40	24.02	19.21	1.18	96.00	48.00	2.50	135.96	0.06	5001.05	4030931.83	530.39
Iwasaki	I 30	0.20	22.20	17.76	1.99	39.37	39.37	2.22	0.00	0.00	5763.75	4327403.81	569.40
Ang_Beng_Ghee	UNIT 4	0.33	15.75	12.60	1.30	31.50	31.50	2.50	0.00	0.00	4437.00	3796816.17	499.58
Ang_Beng_Ghee	UNIT 6	0.33	15.75	12.60	1.14	23.62	23.62	1.88	0.00	0.00	4364.50	3765668.67	495.48
Ang_Beng_Ghee	UNIT 7	0.33	15.75	12.60	1.14	31.50	31.50	2.50	0.00	0.00	4277.50	3727948.16	490.52
Ang_Beng_Ghee	UNIT 16	0.33	15.75	12.60	1.14	31.50	31.50	2.50	94.42	0.10	4843.00	3966724.97	521.94

Ang_Beng_Ghee	UNIT 18	0.33	15.75	12.60	1.14	31.50	31.50	2.50	98.91	0.10	5075.00	4060624.95	534.29
Ang_Beng_Ghee	UNIT 19	0.33	15.75	12.60	1.14	23.62	23.62	1.88	97.11	0.10	4988.00	4025669.14	529.69
Ang_Beng_Ghee	UNIT 20	0.33	15.75	12.60	1.14	27.56	27.56	2.19	181.41	0.18	5321.50	4158070.89	547.11
Ang_Beng_Ghee	UNIT 21	0.33	15.75	12.60	1.14	31.50	31.50	2.50	0.00	0.00	4814.00	3954830.72	520.37
Ang_Beng_Ghee	UNIT 22	0.33	15.75	12.60	1.30	31.50	31.50	2.50	0.00	0.00	4480.50	3815382.62	502.02
Arakawa	UNIT 1	1	10.83	8.66	1.22	23.62	11.81	1.36	0.00	0.00	4176.00	3683452.73	484.66
Arakawa	UNIT 2	1	10.83	8.66	1.22	23.62	11.81	1.36	0.00	0.00	4248.50	3715289.56	488.85
Arakawa	UNIT 4	1	10.83	8.66	1.22	23.62	11.81	1.36	48.33	0.12	4321.00	3746855.88	493.01
Arakawa	UNIT 6	1	10.83	8.66	1.22	23.62	11.81	1.36	48.33	0.13	4147.00	3670640.68	482.98
Arakawa	UNIT 8	1	10.83	8.66	1.22	23.62	11.81	1.36	48.33	0.12	4553.00	3846127.53	506.07
Arakawa	UNIT 9	1	10.83	8.66	1.22	23.62	11.81	1.36	48.33	0.12	4422.50	3790607.14	498.76
Arakawa	UNIT 12	1	10.83	8.66	1.22	23.62	11.81	1.36	96.66	0.26	4031.00	3618938.93	476.18
Arakawa	UNIT 13	1	10.83	8.66	1.22	23.62	11.81	1.36	96.66	0.24	4422.50	3790607.14	498.76
Arakawa	UNIT 14	1	10.83	8.66	1.22	23.62	11.81	1.36	96.66	0.23	4538.50	3839998.24	505.26
Arakawa	UNIT 17	1	10.83	8.66	1.22	23.62	11.81	1.36	48.33	0.12	4538.50	3839998.24	505.26
Arakawa	UNIT 19	1	10.83	8.66	1.22	35.43	17.72	2.05	48.33	0.12	4524.00	3833859.15	504.46
Arakawa	UNIT 22	1	10.83	8.66	1.22	35.43	17.72	2.05	48.33	0.18	2972.50	3107676.38	408.90
Arakawa	UNIT 24	1	10.83	8.66	1.22	23.62	11.81	1.36	96.66	0.23	4509.50	3827710.22	503.65
Arakawa	UNIT 25	1	10.83	8.66	1.22	35.43	17.72	2.05	96.66	0.24	4306.50	3740563.93	492.18
Arakawa	UNIT 27	1	10.83	8.66	1.22	35.43	17.72	2.05	96.66	0.38	2740.50	2983937.75	392.62
Arakawa	UNIT 28	1	10.83	8.66	1.22	35.43	17.72	2.05	96.66	0.18	5988.50	4410967.75	580.39
McDaniel	UNIT S-1	1	24.00	19.20	1.14	48.00	48.00	2.50	4.23	0.00	4321.00	3746855.88	493.01
McDaniel	UNIT S1-2	1	24.00	19.20	1.14	48.00	48.00	2.50	4.23	0.00	3886.00	3553254.00	467.53
McDaniel	UNIT S2	1	24.00	19.20	1.14	48.00	48.00	2.50	4.23	0.00	4524.00	3833859.15	504.46
Hussein	Unit CS-A1	0.50	24.00	19.20	1.38	96.00	48.00	2.50	145.00	0.06	5340.35	4165428.81	548.08
Xiao	Unit CS-A	0.50	24.02	19.21	1.61	72.05	36.02	1.87	146.95	0.06	5205.50	4112501.61	541.12
Yalcin	Specimen BR-C1	1	24.02	19.21	3.05	58.46	58.46	3.04	404.46	0.14	6525.00	4604315.91	605.83
Omar	Specimen S1	0.28	10.00	8.00	1.84	40.00	20.00	2.50	19.00	0.06	4200.65	3694308.03	486.09
Yarandi	Specimen CR-C	1	23.62	18.90	2.41	59.06	59.06	3.13	311.43	0.14	5075.00	4060624.95	534.29

Table A-2-22: Longitudinal reinforcement data of condition iii circular columns

	Longitudinal reinforcement details			Longitudinal steel properties		
Column designation	Bar dia. (in.)	No. of bars	θ	f_{yl} (psi)	f_{ul} (psi)	ρ_l
No.21	0.63	12	0	52635.00	0.00	0.039
No.26	0.63	12	0	52635.00	0.00	0.039
Unit No.1	0.63	20	0	63220.00	94830.00	0.032
Unit No.2	0.63	20	0	42920.00	64380.00	0.032
Unit No.3	0.63	20	0	63220.00	94830.00	0.032
Unit No.5	0.63	20	0	63220.00	94830.00	0.032
Unit No.11	0.63	20	0	64960.00	97440.00	0.032
Unit No.12	0.63	20	0	64960.00	97440.00	0.032
Unit No.13	0.63	20	0	63220.00	94830.00	0.032
Unit No.14	0.94	9	0	61480.00	92220.00	0.032
Unit No.17	0.63	20	0	63220.00	94830.00	0.032
Unit No.23	0.63	20	0	63220.00	94830.00	0.032
Unit No.24	0.63	20	0	63220.00	94830.00	0.032
Unit No.2 (Wong)	0.63	20	0	68875.00	103312.50	0.032
Unit No.10	0.63	8	23	53070.00	79605.00	0.026
Unit No.15	0.63	12	15	52635.00	78952.50	0.039
NR2	0.50	24	0	66990.00	100485.00	0.010
UC13	0.50	14	0	66482.50	99723.75	0.014
UC14	0.50	14	0	66482.50	99723.75	0.014
CCS1	0.75	26	0	45704.00	68556.00	0.025
I 30	0.51	40	0	46835.00	70252.50	0.021
UNIT 4	0.63	20	0	63220.00	97730.00	0.032
UNIT 6	0.63	20	0	63220.00	97730.00	0.032
UNIT 7	0.63	20	0	64960.00	100485.00	0.032
UNIT 16	0.63	20	0	63220.00	98455.00	0.032
UNIT 18	0.63	20	0	63220.00	97730.00	0.032
UNIT 19	0.63	20	0	63220.00	98455.00	0.032
UNIT 20	0.63	20	0	69890.00	109910.00	0.032
UNIT 21	0.63	20	0	63220.00	98455.00	0.032
UNIT 22	0.63	20	0	63220.00	98455.00	0.032
UNIT 1	0.63	12	0	53070.00	0.00	0.039
UNIT 2	0.63	12	0	53070.00	0.00	0.039
UNIT 4	0.63	12	0	53070.00	0.00	0.039
UNIT 6	0.63	12	0	53070.00	0.00	0.039
UNIT 8	0.63	12	0	53070.00	0.00	0.039
UNIT 9	0.63	16	0	53070.00	0.00	0.051
UNIT 12	0.63	12	0	53070.00	0.00	0.039
UNIT 13	0.63	12	0	53070.00	0.00	0.039

UNIT 14	0.63	12	0	53070.00	0.00	0.039
UNIT 17	0.63	12	0	52635.00	0.00	0.039
UNIT 19	0.63	12	0	52635.00	0.00	0.039
UNIT 22	0.63	12	0	52635.00	0.00	0.039
UNIT 24	0.63	12	0	52635.00	0.00	0.039
UNIT 25	0.63	12	0	52635.00	0.00	0.039
UNIT 27	0.63	12	0	52635.00	0.00	0.039
UNIT 28	0.63	12	0	52635.00	0.00	0.039
UNIT S-1	0.63	20	0	65830.00	105792.00	0.014
UNIT S1-2	0.63	20	0	65830.00	105792.00	0.014
UNIT S2	0.63	20	0	63452.00	99760.00	0.014
Unit CS-A1	0.75	20	0	43410.00	65115.00	0.020
Unit CS-A	0.75	20	0	43935.00	65902.50	0.020
Specimen BR-C1	0.98	12	0	64525.00	96787.50	0.020
Specimen S1	0.50	8	0	53803.70	80705.55	0.020
Specimen CR-C	0.77	12	0	67425.00	101137.50	0.013

Table A-2-23: Transverse reinforcement data of condition iii circular columns

	Transverse reinforcement details				Transverse steel properties				
Column designation	Bar dia. (in.)	No. of bars perpendicular to load	No. of bars parallel to load	s (in.)	f_{yt} (psi)	f_{ut} (psi)	Vol. ρ_t	ρ''	s/d
No.21	0.24	2	2	2.95	55245.00	82867.50	0.006	0.003	0.34
No.26	0.24	2	2	2.95	55245.00	82867.50	0.006	0.003	0.34
Unit No.1	0.24	2	2	2.36	47560.00	71340.00	0.005	0.002	0.19
Unit No.2	0.24	2	2	2.36	47560.00	71340.00	0.005	0.002	0.19
Unit No.3	0.24	2	2	2.36	47560.00	71340.00	0.005	0.002	0.19
Unit No.5	0.24	2	2	1.57	47560.00	71340.00	0.008	0.004	0.13
Unit No.11	0.24	2	2	2.36	53940.00	80910.00	0.005	0.002	0.19
Unit No.12	0.24	2	2	1.17	53940.00	80910.00	0.005	0.005	0.09
Unit No.13	0.24	2	2	1.18	47270.00	70905.00	0.010	0.005	0.09
Unit No.14	0.24	2	2	2.36	47270.00	70905.00	0.005	0.002	0.19
Unit No.17	0.24	2	2	2.36	47270.00	70905.00	0.005	0.002	0.19
Unit No.23	0.47	2	2	6.30	48140.00	72210.00	0.008	0.004	0.50
Unit No.24	0.39	2	2	4.33	44950.00	67425.00	0.008	0.004	0.34
Unit No.2 (Wong)	0.24	2	2	2.56	49300.00	73950.00	0.005	0.002	0.20
Unit No.10	0.24	2	2	1.97	53360.00	80040.00	0.009	0.004	0.23
Unit No.15	0.24	2	2	2.95	55245.00	82867.50	0.006	0.003	0.34
NR2	0.25	2	2	5.00	52345.00	78517.50	0.002	0.001	0.26
UC13	0.18	2	2	6.75	100267.50	150401.25	0.001	0.000	0.53
UC14	0.18	2	2	6.75	100267.50	150401.25	0.001	0.000	0.53
CCS1	0.25	2	2	5.00	46124.50	69186.75	0.002	0.001	0.26
I 30	0.35	2	2	8.90	37468.00	56202.00	0.002	0.001	0.50
UNIT 4	0.39	2	2	6.50	45820.00	68730.00	0.005	0.002	0.52
UNIT 6	0.24	2	2	2.36	47560.00	71340.00	0.005	0.002	0.19
UNIT 7	0.24	2	2	3.15	53940.00	80910.00	0.004	0.002	0.25
UNIT 16	0.24	2	2	2.36	47270.00	70905.00	0.005	0.002	0.19
UNIT 18	0.24	2	2	2.36	47270.00	70905.00	0.005	0.002	0.19
UNIT 19	0.24	2	2	3.15	47270.00	70905.00	0.004	0.002	0.25
UNIT 20	0.24	2	2	3.15	47270.00	70905.00	0.004	0.002	0.25
UNIT 21	0.24	2	2	3.15	47270.00	70905.00	0.004	0.002	0.25
UNIT 22	0.39	2	2	8.66	44950.00	67425.00	0.004	0.002	0.69
UNIT 1	0.24	2	2	3.94	53360.00	80040.00	0.005	0.002	0.45
UNIT 2	0.24	2	2	1.97	53360.00	80040.00	0.009	0.004	0.23
UNIT 4	0.24	2	2	3.94	53360.00	80040.00	0.005	0.002	0.45
UNIT 6	0.24	2	2	1.97	53360.00	80040.00	0.009	0.004	0.23
UNIT 8	0.24	2	2	1.38	53360.00	80040.00	0.013	0.006	0.16
UNIT 9	0.24	2	2	1.97	53360.00	80040.00	0.009	0.004	0.23

UNIT 12	0.24	2	2	3.94	53360.00	80040.00	0.005	0.002	0.45
UNIT 13	0.24	2	2	1.97	53360.00	80040.00	0.009	0.004	0.23
UNIT 14	0.24	2	2	1.38	53360.00	80040.00	0.013	0.006	0.16
UNIT 17	0.24	2	2	2.95	55245.00	82867.50	0.006	0.003	0.34
UNIT 19	0.24	2	2	2.95	55245.00	82867.50	0.006	0.003	0.34
UNIT 22	0.24	2	2	2.95	55245.00	82867.50	0.006	0.003	0.34
UNIT 24	0.24	2	2	2.95	55245.00	82867.50	0.006	0.003	0.34
UNIT 25	0.24	2	2	2.95	55245.00	82867.50	0.006	0.003	0.34
UNIT 27	0.24	2	2	2.95	55245.00	82867.50	0.006	0.003	0.34
UNIT 28	0.24	2	2	2.95	55245.00	82867.50	0.006	0.003	0.34
UNIT S-1	0.19	2	2	4.00	29000.00	43500.00	0.001	0.001	0.21
UNIT S1-2	0.19	2	2	4.00	29000.00	43500.00	0.001	0.001	0.21
UNIT S2	0.19	2	2	4.00	29000.00	43500.00	0.001	0.001	0.21
Unit CS-A1	0.25	2	2	5.00	30508.00	45762.00	0.002	0.001	0.26
Unit CS-A	0.25	2	2	5.91	43935.00	65902.50	0.002	0.001	0.31
Specimen BR-C1	0.39	2	2	11.81	61625.00	92437.50	0.002	0.001	0.61
Specimen S1	0.15	2	2	3.85	30502.20	45753.30	0.002	0.001	0.48
Specimen CR-C	0.25	2	2	11.81	71195.00	106792.50	0.001	0.000	0.63

Table A-2-24: Test configurations and modes of failures of condition iii circular columns

Column designation	Test configuration	Failure mode (based on column behavior)
No.21	3	1
No.26	3	1
Unit No.1	1	2
Unit No.2	1	2
Unit No.3	1	2
Unit No.5	1	2
Unit No.11	1	2
Unit No.12	1	2
Unit No.13	1	2
Unit No.14	1	2
Unit No.17	1	2
Unit No.23	1	2
Unit No.24	1	2
Unit No.2 (Wong)	1	2
Unit No.10	3	2
Unit No.15	3	2
NR2	1	2
UC13	1	2
UC14	1	2
CCS1	3	2
I 30	1	2
UNIT 4	1	3
UNIT 6	1	3
UNIT 7	1	3
UNIT 16	1	3
UNIT 18	1	3
UNIT 19	1	3
UNIT 20	1	3
UNIT 21	1	3
UNIT 22	1	3
UNIT 1	3	3
UNIT 2	3	3
UNIT 4	3	3
UNIT 6	3	3
UNIT 8	3	3
UNIT 9	3	3
UNIT 12	3	3
UNIT 13	3	3
UNIT 14	3	3
UNIT 17	3	3
UNIT 19	3	3

Column designation	Test configuration	Failure mode (based on column behavior)
UNIT 22	3	3
UNIT 24	3	3
UNIT 25	3	3
UNIT 27	3	3
UNIT 28	3	3
UNIT S-1	1	3
UNIT S1-2	1	3
UNIT S2	1	3
Unit CS-A1	3	3
Unit CS-A	3	3
Specimen BR-C1	1	3
Specimen S1	3	3
Specimen CR-C	1	3

APPENDIX A-3 EXTRACTED DISPLACEMENT AND LOAD VALUES OF DATABASE COLUMNS

Table A-3-1: Extracted data of condition i rectangular columns

	Based on 0.6 V_{max}		Based on 0.7 V_{max}							Δ at axial failure of column					
Column designation	δ_y (%)	V_y (kips)	δ_y (%)	V_y (kips)	V_{max} (kips)	δ_{vmax} (%)	$\delta_{0.8}$ (%)	δ_S (%)	V_S (kips)	Δ_{bR} (in.)	$\Delta_{b0.25}$ (in.)	Δ_{bmax} (in.)	Δ_{bP} (in.)	δ_{bp} (%)	V_{bP} (kips)
No.1	0.43	112.66	0.51	121.20	156.50	1.44	2.82	2.82	137.85	0.00	0.00	1.33	1.33	2.82	137.85
No.2	0.37	142.81	0.41	152.72	182.41	1.05	2.15	2.15	167.17	0.00	0.00	1.02	1.02	2.15	167.17
No.3	0.30	111.85	0.34	119.33	150.71	1.73	1.76	1.76	131.78	0.00	0.00	0.83	0.83	1.76	131.78
No.4	0.26	121.81	0.30	129.42	156.58	1.30	1.28	1.30	156.58	0.00	0.00	0.60	0.60	1.28	156.33
No.3	0.47	33.18	0.55	35.11	43.17	1.27	3.18	1.27	43.17	0.00	0.00	1.97	1.97	3.12	30.25
No.4	0.50	28.71	0.64	32.01	38.04	1.67	3.60	3.57	28.27	0.00	0.00	2.25	2.25	3.57	28.27
No. 1	0.49	34.66	0.57	36.81	44.87	1.83	4.89	4.69	41.86	3.85	0.00	3.84	3.85	6.10	11.92
No. 2	0.43	47.91	0.52	51.91	62.78	1.01	3.14	1.38	60.11	0.00	3.33	0.00	3.33	5.29	15.70
No. 3	0.37	46.63	0.45	49.93	62.27	0.91	2.79	1.26	60.68	0.00	1.79	0.00	1.79	2.84	15.58
No.7	0.69	38.01	0.78	40.26	47.95	2.09	5.46	4.43	45.23	0.00	0.00	4.65	4.65	7.39	29.03
No.8	0.44	47.84	0.64	51.25	60.44	2.24	6.80	2.90	58.23	0.00	0.00	4.29	4.29	6.82	41.99
No.5	0.45	51.54	0.52	54.81	65.65	1.15	2.29	1.54	61.20	0.00	0.00	1.52	1.52	2.42	36.09
No.6	0.36	50.33	0.41	53.20	66.32	1.06	1.57	1.03	64.49	0.00	1.24	0.00	1.24	1.97	16.58
No.7	0.25	55.45	0.31	59.37	66.44	0.49	1.02	0.75	65.92	0.00	0.86	0.00	0.86	1.37	13.22
No.8	0.26	49.22	0.33	54.48	66.40	0.72	1.16	0.72	66.40	0.00	0.00	0.74	0.74	1.18	37.51
No.9	0.34	57.03	0.34	57.25	69.58	0.88	2.70	1.65	66.94	0.00	0.00	1.76	1.76	2.79	26.39
No1	0.55	27.97	0.68	31.54	37.56	1.15	3.94	3.60	33.01	0.00	0.00	5.10	5.10	8.09	21.03
No2	0.48	27.83	0.59	30.19	37.71	1.14	5.34	4.89	29.82	0.00	0.00	5.09	5.09	8.08	16.61
No3	0.38	27.37	0.57	32.46	39.41	1.48	3.56	3.31	34.36	0.00	0.00	3.02	3.02	4.79	15.51
No4	0.43	27.50	0.62	32.14	38.31	1.16	4.84	3.73	32.13	0.00	0.00	4.65	4.65	7.38	23.03
No5	0.65	68.60	0.76	74.83	86.69	4.17	4.64	4.64	80.44	0.00	0.00	3.02	3.02	4.64	80.44
No6	0.60	71.06	0.73	78.32	91.99	2.56	6.80	5.29	84.16	0.00	0.00	4.42	4.42	6.81	71.30

No7	0.53	100.35	0.63	108.80	138.64	1.91	4.98	5.03	104.40	0.00	0.00	3.27	3.27	5.03	104.40
No8	0.51	105.10	0.61	112.45	139.08	1.44	5.17	5.20	108.20	0.00	0.00	3.38	3.38	5.20	108.20
No9	1.16	69.13	1.35	74.15	88.81	4.76	11.78	5.89	79.93	0.00	0.00	8.28	8.28	11.78	79.93
No.102	0.27	29.41	0.31	31.80	36.08	1.02	1.77	1.77	34.24	0.00	0.00	0.52	0.52	1.77	34.24
L1	0.61	21.73	0.66	22.89	27.21	4.42	5.13	5.13	27.02	0.00	0.00	3.23	3.23	5.13	27.02
L2	0.47	19.41	0.55	21.37	24.44	3.60	6.13	6.13	22.10	0.00	0.00	3.86	3.86	6.13	22.10
L3	0.48	18.83	0.53	19.85	24.76	3.22	4.57	3.25	24.65	0.00	0.00	2.94	2.94	4.67	13.60
214-08	0.50	10.92	0.62	11.83	16.23	0.91	2.04	1.37	14.99	0.00	0.00	0.80	0.80	3.17	4.90
85STC-1	0.60	14.54	0.64	15.18	18.41	1.73	4.61	4.61	15.16	0.00	0.00	4.13	4.13	7.00	10.02
85STC-2	0.48	13.78	0.59	15.40	17.99	1.60	4.61	4.61	15.02	0.00	0.00	4.13	4.13	7.00	10.40
85STC-3	0.60	14.61	0.64	15.24	18.41	1.73	4.61	4.61	15.16	0.00	0.00	4.13	4.13	7.00	10.02
85PDC-1	0.58	14.84	0.67	15.96	19.01	1.75	2.29	2.24	18.60	0.00	0.00	1.35	1.35	2.29	18.48
85PDC-2	0.45	12.90	0.53	13.91	18.34	1.34	2.51	2.51	15.45	0.00	0.00	1.48	1.48	2.51	15.45
85PDC-3	0.48	12.98	0.56	13.90	17.42	1.66	2.86	2.86	16.37	0.00	0.00	1.69	1.69	2.86	16.37
AL-1	0.53	43.25	0.60	44.96	54.53	0.96	5.82	2.81	52.62	0.00	0.00	1.22	1.22	6.21	41.28
AH-1	0.59	44.47	0.63	45.62	54.88	2.01	10.02	5.02	50.65	0.00	0.00	1.98	1.98	10.08	44.39
AL-2	0.57	44.96	0.60	46.76	54.43	1.52	2.07	1.52	54.43	0.00	0.00	0.57	0.57	2.89	20.24
AH-2	0.55	44.76	0.62	47.02	55.45	1.51	4.13	2.87	53.28	0.00	0.00	1.62	1.62	8.25	30.27
BH-1	0.53	44.49	0.58	46.80	57.45	1.05	8.50	6.43	50.33	0.00	0.00	1.69	1.69	8.59	43.71
BL-2	0.54	51.98	0.61	55.16	64.89	0.75	3.41	1.92	63.72	0.00	0.00	1.23	1.23	6.24	38.00
BH-2	0.57	55.32	0.63	58.70	64.76	1.53	6.01	4.86	54.83	0.00	0.00	1.41	1.41	7.19	41.28
B2	0.45	74.79	0.53	80.30	92.99	1.01	4.01	2.51	86.09	0.00	0.00	1.60	1.60	4.06	70.62
B4	0.52	77.00	0.57	80.75	91.09	1.00	2.00	1.42	84.99	0.00	0.00	1.62	1.62	4.12	31.00
B5	0.51	78.52	0.57	82.70	91.18	0.84	1.74	1.41	86.57	0.00	0.00	0.99	0.99	2.52	34.93
No.1S1	0.74	11.36	0.81	12.20	13.87	1.05	2.50	2.50	13.54	0.00	0.00	1.65	1.65	2.50	13.54
No.3S1	0.65	10.17	0.87	12.23	13.09	0.99	3.07	3.07	11.29	0.00	0.00	2.02	2.02	3.07	11.29
No.5S1	0.85	13.53	0.97	14.57	17.23	1.23	3.08	3.08	14.58	0.00	0.00	2.03	2.03	3.08	14.58
No.9	0.78	14.63	0.90	16.00	17.73	1.21	2.25	3.19	11.85	0.00	0.00	2.10	2.10	3.19	11.85
No.11	0.66	14.43	0.71	15.25	18.46	1.17	2.23	1.54	16.65	0.00	0.00	1.96	1.96	2.96	9.13
NC 2	0.75	90.61	0.79	94.44	104.93	1.83	4.89	4.25	86.75	0.00	0.00	2.75	2.75	5.09	33.09
NC 4	0.63	91.64	0.65	93.18	109.99	1.17	2.87	2.28	101.24	0.00	0.00	1.54	1.54	2.84	77.21

U4	1.26	59.71	1.38	63.10	73.26	6.81	9.29	8.99	63.28	0.00	0.00	4.02	4.02	10.20	45.12
U6	1.28	59.37	1.51	64.01	77.06	6.44	8.90	8.70	75.31	0.00	0.00	3.50	3.50	8.90	62.00
U7	1.30	60.74	1.53	66.50	76.84	6.56	8.78	8.52	74.95	0.00	0.00	3.46	3.46	8.80	58.47
BA1	0.70	26.66	0.76	27.62	31.75	1.30	1.93	1.54	30.77	0.00	1.46	0.00	1.46	3.25	7.85
BA2	0.72	22.93	0.82	24.42	28.86	1.33	2.13	1.33	28.86	0.00	0.00	1.47	1.47	3.28	8.41
BA3	0.76	24.18	0.83	25.21	29.47	1.21	1.76	1.21	29.47	0.00	1.35	0.00	1.35	3.02	7.38
BA4	0.80	19.79	0.89	21.16	24.80	1.27	2.05	1.42	24.53	0.00	0.00	1.85	1.85	4.11	6.37
CA1	0.70	17.82	0.79	18.71	22.71	1.40	3.38	1.40	22.71	0.00	0.00	2.64	2.64	5.88	8.10
CA2	0.72	23.33	0.78	24.15	28.43	1.47	2.96	1.62	28.37	0.00	0.00	2.16	2.16	4.81	7.54
CA3	0.64	22.78	0.73	23.99	29.59	1.37	3.11	1.37	29.59	0.00	0.00	2.30	2.30	5.13	9.69
CA4	0.77	24.18	0.86	25.34	30.30	1.44	2.12	1.44	30.30	0.00	0.00	2.40	2.40	5.34	7.99
BB4	1.00	32.21	1.08	35.57	39.34	1.51	3.55	3.42	33.51	0.00	0.00	2.83	2.83	6.30	19.91
BB4B	0.98	31.26	1.06	32.52	38.33	1.57	4.27	3.71	30.18	0.00	0.00	2.97	2.97	6.61	22.54
CB1	1.22	32.13	1.33	33.78	38.56	2.20	5.24	4.16	32.83	0.00	0.00	3.64	3.64	8.10	21.65
CB2	1.10	30.27	1.25	32.62	38.91	2.47	5.40	1.77	37.52	0.00	0.00	3.53	3.53	7.87	21.29
CB3	1.16	30.81	1.28	32.32	38.30	2.62	5.16	2.62	38.31	0.00	0.00	3.77	3.77	8.39	21.86
CB4	1.07	31.86	1.16	33.35	39.76	2.65	5.26	3.28	37.36	0.00	0.00	3.74	3.74	8.33	17.14
B1	1.56	72.31	1.54	71.81	85.41	5.88	6.89	6.87	80.62	7.23	0.00	7.23	7.23	7.87	42.74
B2	1.34	80.05	1.47	85.26	96.87	4.48	5.55	5.42	96.10	5.95	0.00	5.95	5.95	6.47	57.00
HC4-8L19-T10-0.1P	0.98	58.68	1.08	62.95	72.86	6.90	7.03	6.90	72.86	3.80	0.00	3.80	3.80	9.49	26.79
HC4-8L19-T10-0.2P	1.09	76.53	1.07	75.95	85.05	2.91	5.85	7.75	76.48	0.00	0.00	3.61	3.61	9.03	32.88
HC4-8L16-T10-0.1P	0.86	50.04	0.96	53.32	61.92	2.64	7.29	7.19	54.24	0.00	0.00	3.06	3.06	7.64	34.13
HC4-8L16-T10-0.2P	0.93	57.96	1.01	60.81	71.68	3.41	6.78	6.05	62.58	0.00	0.00	3.49	3.49	8.72	34.96
UC10H	0.34	65.08	0.35	67.05	75.14	0.68	0.72	0.68	75.14	0.00	0.00	0.32	0.32	0.91	48.11
UC15H	0.39	72.93	0.41	74.65	82.05	0.86	1.80	1.21	80.76	0.00	0.94	0.00	0.94	2.65	20.50
UC20H	0.44	73.44	0.44	73.62	91.89	1.17	2.70	1.35	91.66	0.00	1.62	0.00	1.62	4.58	23.00
UC15L	0.43	69.48	0.44	70.64	82.67	0.88	2.73	1.35	81.72	0.00	0.00	2.55	2.55	7.19	23.21
UC20L	0.44	71.15	0.45	72.21	83.18	1.34	3.64	2.25	75.99	0.00	0.00	2.55	2.55	7.21	37.32

ES-1HT	0.20	24.42	0.24	26.38	33.11	0.46	1.48	0.46	33.11	0.00	0.00	1.46	1.46	2.01	15.59
AS-2HT	0.28	27.32	0.33	29.26	33.56	0.54	2.39	2.28	25.91	0.00	0.00	2.88	2.88	3.97	9.83
AS-3HT	0.23	26.14	0.26	28.06	33.23	0.48	1.74	1.32	29.59	0.00	1.75	0.00	1.75	2.42	8.07
AS-4HT	0.35	25.73	0.40	28.29	33.19	0.98	2.26	1.72	28.12	0.00	2.85	0.00	2.85	3.93	8.30
AS-5HT	0.19	33.64	0.21	34.96	44.83	0.30	0.65	0.54	33.59	0.00	0.00	1.17	1.17	1.62	14.70
AS-6HT	0.43	33.95	0.44	35.00	44.19	0.48	1.54	1.83	33.48	0.00	2.54	0.00	2.54	3.51	9.50
AS-7HT	0.41	32.06	0.45	33.59	38.65	0.53	1.25	0.78	32.12	0.00	1.58	0.00	1.58	2.18	9.65
ES-8HT	0.28	33.91	0.31	36.17	40.01	0.40	0.98	0.78	38.13	0.00	0.00	1.16	1.16	1.60	13.69
BG-2	0.55	32.73	0.63	35.36	42.96	1.64	4.04	3.98	35.91	0.00	0.00	3.27	3.27	5.05	29.34
BG-3	0.72	27.46	0.92	30.65	36.93	1.92	7.05	7.02	31.07	0.00	0.00	4.57	4.57	7.05	27.34
BG-5	0.64	34.02	0.88	39.72	53.35	1.64	6.02	6.02	44.91	0.00	0.00	4.61	4.61	7.11	14.70
BG-6	0.63	36.27	0.82	40.15	49.78	3.01	6.05	6.02	44.91	0.00	0.00	4.61	4.61	7.11	14.70
BG-7	0.62	34.71	0.87	41.86	48.44	1.92	6.08	6.02	44.91	0.00	0.00	4.61	4.61	7.11	14.70
BG-8	1.05	34.34	1.21	37.66	44.62	1.95	7.08	6.99	40.17	0.00	0.00	4.57	4.57	7.05	23.31
BG-9	0.61	35.34	0.88	42.45	49.31	1.95	7.05	6.99	40.18	0.00	0.00	4.57	4.57	7.05	23.31
BG-10	0.78	39.35	0.81	40.19	53.50	2.34	6.99	6.99	40.18	0.00	0.00	4.57	4.57	7.05	23.30
C10-10N	1.10	16.49	1.25	17.91	21.50	2.82	6.25	7.29	16.10	0.00	0.00	1.71	1.71	7.12	11.30
C10-10S	1.05	16.29	1.19	17.73	21.20	1.98	6.25	7.20	15.70	0.00	0.00	1.73	1.73	7.20	11.70
C10-20N	1.01	18.97	1.13	19.70	24.20	2.82	5.20	4.50	20.30	0.00	0.00	1.52	1.52	6.33	11.70
C10-20S	0.97	17.88	1.08	18.69	23.30	3.03	5.20	4.37	20.10	0.00	0.00	1.51	1.51	6.29	12.20
C5-00N	1.52	11.45	1.65	11.99	13.30	3.06	6.37	7.45	9.50	0.00	0.00	2.00	2.00	8.33	8.83
C5-00S	1.43	11.03	1.57	11.80	13.11	3.08	6.38	7.46	9.15	0.00	0.00	2.00	2.00	8.33	8.66
C5-40N	0.91	15.02	0.99	15.86	19.00	2.10	4.21	4.21	15.60	0.00	0.00	1.01	1.01	4.21	13.51
C5-40S	0.93	15.16	1.01	15.65	19.00	2.10	4.16	4.16	15.60	0.00	0.00	1.00	1.00	4.16	13.60
C1-1	1.06	46.39	1.14	48.78	56.20	2.42	6.12	5.88	46.63	0.00	0.00	4.02	4.02	7.30	25.41
C1-2	1.07	50.04	1.14	51.53	60.15	2.56	6.90	6.39	53.13	0.00	0.00	4.14	4.14	7.50	17.18
C1-3	1.22	56.62	1.35	60.29	68.63	2.47	5.84	7.31	60.10	0.00	0.00	4.34	4.34	7.88	31.39
C2-1	1.23	46.60	1.28	47.60	55.76	2.62	6.93	6.83	49.51	0.00	0.00	4.38	4.38	7.95	18.44
C2-2	1.01	48.56	1.13	52.72	64.21	2.59	6.85	6.78	54.33	0.00	4.20	0.00	4.20	7.62	16.00
C2-3	1.11	57.88	1.20	61.35	69.65	2.74	5.19	6.94	61.91	0.00	0.00	4.52	4.52	8.19	26.67
C3-1	1.13	42.96	1.23	45.74	56.75	2.82	6.73	6.70	47.59	0.00	0.00	4.22	4.22	7.65	26.95

C3-2	1.16	49.67	1.26	52.55	63.50	2.46	6.78	6.76	54.50	0.00	0.00	4.45	4.45	8.07	26.67
C3-3	1.25	57.32	1.31	59.42	68.05	4.12	6.04	7.40	62.90	0.00	0.00	4.76	4.76	8.64	26.67
ORC1	1.70	48.32	1.74	49.54	58.03	3.75	6.06	5.89	56.82	0.00	0.00	4.36	4.36	6.06	44.40
ORC2	1.63	67.96	1.85	74.25	87.31	3.13	4.96	4.39	79.19	0.00	0.00	4.10	4.10	5.70	47.18
ORC3	1.52	77.63	1.64	79.43	95.36	2.12	3.88	2.26	93.66	0.00	0.00	3.66	3.66	5.08	45.29
A1	1.39	7.40	1.55	8.02	10.44	3.68	5.23	4.81	10.25	0.00	0.00	1.24	1.24	5.29	7.44
A3	0.56	12.26	0.69	13.38	16.45	1.56	3.39	4.54	10.41	0.00	1.33	0.00	1.33	5.66	4.11
B1	0.95	5.73	1.00	5.79	9.13	4.54	4.81	4.54	9.13	0.00	0.00	1.13	1.13	4.81	7.71
B2	0.75	9.29	0.83	10.19	12.55	1.62	3.28	2.85	10.59	0.00	0.00	1.48	1.48	6.29	8.21
B3	0.43	10.70	0.52	11.36	14.66	1.00	1.92	2.25	11.68	0.00	0.00	1.56	1.56	6.66	4.27
C1	1.33	6.79	1.46	7.18	8.99	4.44	6.09	4.44	8.99	0.00	0.00	1.43	1.43	6.09	8.21
C2	0.61	8.07	0.72	8.92	11.51	1.77	3.27	2.61	11.03	0.00	0.00	1.58	1.58	6.73	7.34
C3	0.43	9.39	0.51	10.19	12.98	1.25	3.07	2.54	10.54	0.00	1.61	0.00	1.61	6.85	3.27
D1	0.40	9.29	0.52	10.25	12.82	1.26	2.29	1.26	12.82	0.00	1.54	0.00	1.54	6.54	3.27
D2	0.50	10.09	0.61	10.76	14.11	1.22	2.02	1.28	13.30	0.00	0.00	1.57	1.57	6.67	3.95
D3	0.49	8.70	0.64	9.85	12.06	1.08	2.11	1.51	11.99	0.00	0.00	1.55	1.55	6.60	3.17
1006015	0.84	19.73	1.04	22.02	27.65	1.46	7.57	8.12	20.82	0.00	0.00	8.37	8.37	10.63	11.15
1006025	0.88	29.27	0.95	30.37	35.92	1.56	5.27	1.56	35.92	0.00	7.87	0.00	7.87	10.00	8.44
1006040	0.99	32.37	1.00	32.63	43.84	1.23	3.32	3.32	34.84	0.00	5.55	0.00	5.55	7.05	10.10
10013015	0.79	18.32	0.91	19.32	25.16	1.52	4.55	4.55	19.97	0.00	0.00	4.80	4.80	6.09	8.30
10013025	0.80	29.72	0.90	31.49	37.71	1.44	2.28	2.83	27.68	0.00	0.00	3.77	3.77	4.79	14.72
10013040	0.83	36.34	0.84	36.87	41.59	1.24	1.46	1.24	41.59	0.00	0.00	1.90	1.90	2.42	18.95
806040	0.94	33.96	0.96	34.18	38.04	3.34	8.69	8.72	34.04	0.00	0.00	8.20	8.20	10.42	25.23
1206040	0.98	43.19	1.02	44.10	47.86	2.70	6.10	6.07	39.29	0.00	0.00	6.39	6.39	8.12	30.36
1005540	1.03	39.65	1.07	40.39	44.56	1.32	5.37	7.11	33.58	0.00	0.00	6.65	6.65	8.45	26.43
1008040	0.94	34.64	0.96	34.93	45.34	1.19	2.83	3.10	34.10	0.00	0.00	4.25	4.25	5.40	22.69
1005552	0.55	29.80	0.59	31.69	45.31	1.00	3.31	2.54	38.27	0.00	0.00	3.62	3.62	4.59	24.19
1006052	0.55	27.42	0.62	30.43	47.32	0.72	3.30	2.69	44.33	0.00	0.00	3.56	3.56	4.52	21.54
10-3-1.5N	0.90	22.41	0.93	22.84	26.08	2.79	4.11	4.22	18.28	0.00	0.00	2.28	2.28	4.22	18.28
10-3-1.5S	0.75	21.01	0.81	22.45	26.08	2.92	4.16	4.16	21.75	0.00	0.00	2.35	2.35	4.35	13.10
D1N60	0.68	40.99	0.68	41.15	42.28	0.77	2.00	1.67	33.27	0.00	0.00	0.73	0.73	2.97	21.15

L1D60	0.40	218.13	0.37	205.71	278.53	0.75	2.46	3.70	192.00	0.00	0.00	1.89	1.89	4.00	177.12
L1N60	0.56	302.00	0.62	305.00	300.95	0.71	2.25	1.46	263.10	0.00	0.00	1.23	1.23	2.61	182.65
L1N6B	0.83	263.36	0.86	265.66	270.06	1.92	1.94	2.35	265.85	0.00	0.00	1.43	1.43	3.02	243.78
HPRC19-32	0.35	18.94	0.42	20.37	25.32	0.99	1.51	0.99	25.32	0.00	0.00	0.96	0.96	4.06	7.75
204-08	0.27	11.88	0.29	12.42	15.22	0.51	0.81	0.83	13.98	0.00	0.00	0.53	0.53	2.10	8.88
223-09	0.58	12.03	0.63	12.36	15.15	1.92	3.47	1.92	15.15	0.00	0.00	0.98	0.98	3.91	8.35
302-07	0.28	7.87	0.31	8.56	12.71	0.65	1.52	1.40	10.45	0.00	0.00	0.57	0.57	1.50	7.90
312-07	0.30	9.42	0.34	10.01	12.34	0.68	1.60	0.92	11.60	0.00	0.00	0.62	0.62	1.64	7.65
CA025C	0.44	21.62	0.55	23.85	29.27	1.49	2.54	2.01	28.02	0.00	0.00	0.71	0.71	3.02	13.52
CA060C	0.32	24.70	0.29	24.03	30.73	0.78	1.01	0.84	28.45	0.00	0.00	0.36	0.36	1.53	13.20
CB060C	0.17	61.56	0.25	76.96	115.47	0.85	0.90	0.85	115.47	0.00	0.00	0.26	0.26	1.03	52.70
WI_40_147_E	1.57	20.23	1.76	22.93	26.92	5.86	5.90	5.86	26.92	0.00	0.00	2.03	2.03	5.90	26.17
WI_40_147_W	1.31	20.91	1.47	22.26	27.08	6.08	6.23	6.17	25.78	0.00	0.00	2.15	2.15	6.23	22.79
WI_40_092_E	1.21	21.13	1.30	21.81	27.24	5.90	5.87	5.90	27.24	0.00	0.00	2.03	2.03	5.89	19.27
WI_40_092_W	1.30	21.36	1.50	22.48	27.21	5.70	5.74	5.70	27.21	0.00	0.00	2.09	2.09	6.06	20.66
I_25	0.42	70.02	0.47	79.52	88.65	0.68	2.47	2.34	81.83	0.00	1.92	0.00	1.92	4.20	17.86
HPRC_1063	0.00	0.00	0.00	0.00	19.67	0.87	1.57	1.30	19.54	0.00	0.00	0.60	0.60	2.55	7.96
UNIT_10408	0.00	0.00	0.00	0.00	18.64	0.94	1.07	1.02	18.59	0.00	0.26	0.00	0.26	2.06	4.66
UNIT_11408	0.00	0.00	0.00	0.00	20.53	1.06	2.04	1.61	19.09	0.00	0.26	0.00	0.26	2.04	5.13
UNIT_12408	0.00	0.00	0.00	0.00	25.84	1.84	3.96	3.37	25.67	0.00	0.00	0.51	0.51	4.05	8.07

Table A-3-2: Extracted data of condition ii rectangular columns

	Based on 0.6 V_{max}		Based on 0.7 V_{max}							Δ at axial failure of column					
Column designation	δ_y (%)	V_y (kips)	δ_y (%)	V_y (kips)	V_{max} (kips)	δ_{vmax} (%)	$\delta_{0.8}$ (%)	δ_S (%)	V_S (kips)	Δ_{bR} (in.)	$\Delta_{b0.25}$ (in.)	Δ_{bmax} (in.)	Δ_{bP} (in.)	δ_{bp} (%)	V_{bP} (kips)
No. 4	0.43	44.72	0.52	48.15	59.47	1.08	2.16	1.47	57.80	0.00	1.97	0.00	1.97	3.13	13.33
BL-1	0.56	45.27	0.59	46.95	57.25	0.87	6.36	5.18	46.48	0.00	0.00	1.47	1.47	7.44	35.48
B1	0.49	74.85	0.57	80.08	92.71	0.81	2.01	1.41	87.66	0.00	0.00	0.81	0.81	2.05	59.90
B3	0.69	85.23	0.64	82.11	96.29	1.01	1.83	0.81	95.79	0.00	0.66	0.00	0.66	1.66	24.00
B6	0.57	81.48	0.64	85.31	94.43	0.91	1.96	1.40	86.66	0.00	0.00	1.04	1.04	2.64	42.23
B7	0.27	62.20	0.31	66.69	91.06	0.81	1.06	0.81	91.06	0.00	0.88	0.00	0.88	2.24	20.40
No.2S1	0.81	11.78	0.95	13.34	13.76	1.08	3.13	3.13	11.66	0.00	0.00	2.06	2.06	3.13	11.66
No.4S1	0.73	9.24	0.78	9.68	16.01	1.76	2.38	2.40	10.00	0.00	0.00	1.58	1.58	2.40	10.00
No.6S1	0.92	14.08	0.98	14.55	16.84	1.84	3.08	2.79	15.24	0.00	0.00	2.02	2.02	3.06	13.30
No.10	0.68	13.88	0.72	14.27	17.53	1.52	2.39	1.97	15.58	0.00	0.00	1.95	1.95	2.96	10.22
No.12	0.90	14.52	0.94	14.90	17.64	1.56	2.52	2.47	15.63	0.00	0.00	2.01	2.01	3.04	6.27
U1	1.55	49.49	1.72	51.61	62.09	4.52	4.85	4.52	56.49	0.00	3.30	0.00	3.30	8.39	15.64
U3	1.47	48.94	1.65	52.62	60.92	1.83	5.11	2.71	60.02	0.00	0.00	2.61	2.61	6.64	21.00
AA1	0.73	24.05	0.79	24.73	29.26	1.21	1.36	1.21	29.26	0.00	1.24	0.00	1.24	2.77	7.31
AA2	0.75	22.35	0.80	23.07	27.68	1.37	1.50	1.37	27.68	0.00	1.30	0.00	1.30	2.91	6.80
AA3	0.66	16.73	0.74	17.53	22.09	1.32	1.64	1.38	21.43	0.00	1.73	0.00	1.73	3.86	5.52
AA4	0.63	24.17	0.70	25.85	30.93	1.22	1.38	1.22	30.93	0.00	1.29	0.00	1.29	2.87	7.72
AB1	1.20	32.17	1.34	34.36	39.41	1.81	4.27	2.32	37.91	0.00	0.00	1.91	1.91	4.26	28.53
AB2	0.92	30.73	0.99	31.88	37.12	1.72	3.42	2.34	36.12	0.00	0.00	1.80	1.80	4.02	26.32
AB3	1.00	29.76	1.12	31.43	38.91	1.75	3.74	1.75	38.91	0.00	0.00	1.63	1.63	3.64	27.61
AB4	1.12	35.67	1.31	38.85	46.03	1.87	3.45	1.87	46.03	0.00	1.75	0.00	1.75	3.90	11.25
BB	1.16	29.00	1.28	30.76	36.33	2.05	4.73	2.05	36.33	0.00	0.00	2.75	2.75	6.12	19.65
BB1	0.92	34.18	1.08	37.30	43.86	2.06	3.13	2.06	43.86	0.00	0.00	2.16	2.16	4.80	15.19
A1	1.28	67.72	1.41	71.80	82.82	5.16	5.23	5.23	82.27	6.41	0.00	6.41	6.41	6.98	57.05
A2	0.98	72.19	1.12	78.62	89.98	3.43	4.38	4.34	88.99	4.81	0.00	4.81	4.81	5.24	50.40

No.1	0.63	9.75	0.71	10.64	14.78	1.48	1.61	1.60	14.44	0.00	0.00	1.37	1.37	1.63	5.34
BG-1	0.62	33.58	0.77	37.25	43.76	1.58	3.01	2.58	34.95	0.00	0.00	1.95	1.95	3.01	28.34
BG-4	0.25	29.93	0.57	38.70	46.47	1.43	3.07	5.05	29.34	0.00	0.00	3.27	3.27	5.05	29.34
C10-05N	1.23	12.48	1.33	13.13	15.80	2.07	5.25	7.33	10.40	0.00	0.00	2.06	2.06	8.58	7.35
C10-05S	1.10	12.06	1.28	13.08	15.30	1.94	5.20	7.29	10.30	0.00	0.00	1.75	1.75	7.29	9.41
C5-20N	0.94	12.28	1.15	13.86	16.30	1.90	4.18	5.21	11.11	0.00	0.00	1.74	1.74	7.25	5.96
C5-20S	0.90	12.14	1.00	12.67	16.30	1.93	4.15	5.03	10.90	0.00	0.00	1.73	1.73	7.20	6.34
10-2-3N	0.84	21.46	0.91	23.02	25.52	2.96	2.99	2.90	24.75	0.00	0.00	1.71	1.71	3.16	12.39
10-2-3S	0.71	19.33	0.83	21.50	25.52	3.02	3.02	3.05	23.93	0.00	0.00	1.65	1.65	3.05	23.93
10-3-3N	0.89	21.91	0.96	23.25	25.52	2.76	3.13	3.18	21.02	0.00	0.00	1.77	1.77	3.28	10.83
10-3-3S	0.84	22.21	0.92	22.96	25.52	2.72	3.13	3.15	22.63	0.00	0.00	1.70	1.70	3.15	22.63
10-3-2.25N	0.63	17.59	0.75	19.87	25.65	2.87	3.03	2.95	21.17	0.00	0.00	1.73	1.73	3.20	15.95
10-3-2.25S	0.56	16.41	0.70	18.68	25.65	2.84	3.22	3.22	21.54	0.00	0.00	1.74	1.74	3.22	21.54
20-3-3N	0.78	25.10	0.83	26.01	29.38	1.76	3.41	3.30	25.85	0.00	0.00	1.85	1.85	3.43	22.42
20-3-3S	0.66	23.23	0.81	25.93	29.38	1.63	3.35	2.97	28.93	0.00	1.81	0.00	1.81	3.36	7.30
10-2-2.25N	0.75	21.24	0.86	22.61	26.03	1.98	3.01	3.01	20.56	0.00	0.00	1.73	1.73	3.21	20.45
10-2-2.25S	0.73	21.13	0.86	23.18	26.03	1.98	3.16	3.17	22.07	0.00	0.00	1.71	1.71	3.17	22.07
10-1-2.25N	0.74	20.83	0.85	22.83	26.47	3.03	3.20	3.21	22.93	0.00	0.00	1.74	1.74	3.21	22.93
10-1-2.25S	0.74	20.83	0.87	22.63	26.47	2.97	2.98	2.98	20.34	0.00	0.00	1.64	1.64	3.04	15.27
D1N30	0.89	42.03	0.93	42.40	45.19	2.94	2.97	3.96	29.19	0.00	0.00	0.97	0.97	3.96	29.19
Test 1	0.59	29.58	0.65	31.45	34.12	1.38	3.51	3.01	32.35	0.00	0.00	3.01	3.01	6.14	8.88
Test 2	0.77	28.26	0.83	30.00	33.26	1.36	4.30	3.89	32.05	0.00	2.58	0.00	2.58	5.27	8.05
Test 3	0.56	26.66	0.66	29.18	34.42	2.87	5.95	2.92	33.37	0.00	0.00	3.60	3.60	7.35	10.50
Test 4	0.63	29.79	0.69	30.63	35.31	1.82	8.15	1.82	35.31	0.00	0.00	4.42	4.42	9.01	6.49
Test 5	0.59	29.22	0.62	30.07	35.85	2.80	7.23	4.79	34.39	0.00	0.00	3.76	3.76	7.68	20.67
Test 6	0.64	30.91	0.74	32.60	38.35	7.99	8.49	7.99	38.35	0.00	0.00	4.16	4.16	8.49	35.93
2D16RS	0.77	17.13	0.88	18.41	22.79	1.60	3.83	3.30	20.70	0.00	0.00	1.37	1.37	4.36	6.41
4D13RS	0.73	19.56	0.83	20.65	24.86	1.28	1.80	1.65	24.80	0.00	0.00	1.07	1.07	3.39	8.83
1007	2.24	5.99	2.39	6.27	8.26	4.33	4.18	4.33	8.26	0.00	0.00	0.29	0.29	4.58	3.48
WI_40_048E	1.17	19.11	1.37	20.73	23.51	2.78	4.88	4.86	23.42	0.00	0.00	1.68	1.68	4.88	18.65
WI_40_048W	1.15	18.74	1.37	20.52	22.14	5.49	5.41	5.49	22.14	0.00	1.93	0.00	1.93	5.59	5.07

WI_25_033_E	1.19	15.44	1.35	16.43	19.76	3.52	3.53	3.52	19.76	0.00	0.00	1.73	1.73	5.02	5.24
WI_25_033_W	1.17	16.86	1.23	17.96	20.97	3.42	3.65	3.42	20.97	0.00	0.00	1.66	1.66	4.80	18.08
WI_0_048W	1.18	18.96	1.36	20.29	22.11	2.59	5.53	5.43	22.07	0.00	1.94	0.00	1.94	5.62	5.13
WI_40_067_E	1.37	18.43	1.45	18.84	22.83	6.86	6.79	6.86	22.83	0.00	0.00	2.34	2.34	6.79	21.51
WI_40_067_W	1.04	17.53	1.16	18.66	22.34	6.70	6.82	6.70	22.34	0.00	0.00	2.35	2.35	6.82	16.49
2CLH18	0.55	45.00	0.61	48.45	54.13	1.92	2.59	2.57	53.36	3.60	0.00	3.64	3.60	3.10	22.26
2CMH18	0.46	53.74	0.51	56.29	68.79	0.96	0.96	1.01	68.56	1.16	1.81	0.00	1.16	1.00	53.21
2SLH18	0.46	40.57	0.51	42.66	52.38	0.90	1.95	1.11	49.46	4.14	0.00	4.14	4.14	3.57	20.84
3SMD12	0.52	58.42	0.59	62.81	82.50	1.57	1.68	1.57	82.50	2.44	2.30	0.00	2.44	2.10	6.75
HC4-8L16-T6-0.1P	0.87	44.80	0.98	48.38	60.68	1.55	6.40	5.66	52.75	0.00	0.00	2.52	2.52	6.30	21.88
HC4-8L16-T6-0.2P	0.72	56.66	0.82	60.77	72.86	1.73	3.72	3.44	63.10	0.00	1.68	0.00	1.68	4.20	17.61
Specimen_1	0.79	52.72	0.89	55.68	70.76	1.84	2.55	1.84	70.76	5.76	0.00	3.41	5.76	4.96	3.15
Specimen_2	0.45	53.68	0.51	57.77	80.73	0.86	1.52	1.19	62.35	2.11	2.03	0.00	2.11	1.82	8.34
Specimen_4	0.79	50.27	0.87	52.85	66.22	2.05	2.89	2.05	66.22	5.92	5.91	0.00	5.92	5.10	16.40
I_03	0.47	22.15	0.74	23.82	28.80	3.95	3.95	3.95	28.80	0.00	0.00	4.60	4.60	4.87	12.84
I_04	0.92	35.24	0.95	35.90	35.97	2.38	3.20	2.38	35.97	0.00	0.00	3.95	3.95	4.18	15.51
I_10	0.89	30.44	1.03	34.75	35.39	2.17	3.34	2.17	35.40	0.00	0.00	4.36	4.36	4.43	11.28
I_14	0.89	29.38	1.07	32.91	34.91	1.51	2.68	2.18	32.57	0.00	0.00	3.52	3.52	3.57	10.84
I_16	0.89	30.80	1.09	36.56	36.65	2.70	2.20	2.70	36.65	0.00	0.00	4.31	4.31	4.38	11.26
I_17	0.76	49.56	0.84	53.12	53.57	0.85	2.72	1.30	50.79	0.00	2.51	0.00	2.51	3.64	13.05
I_20	0.54	33.47	0.64	38.96	51.71	1.34	2.76	1.82	50.61	0.00	0.00	2.73	2.73	3.96	13.30
IK_43	0.60	14.08	0.67	15.06	16.80	1.69	2.63	2.06	16.30	0.00	0.00	0.62	0.62	3.17	12.87
IK_44	0.54	12.73	0.61	13.87	15.92	1.51	1.64	1.51	15.92	0.00	0.00	0.41	0.41	2.09	12.53
IK_45	0.63	15.10	0.65	15.52	18.80	1.19	1.56	1.62	18.15	0.00	0.00	0.42	0.42	2.12	12.07
IK_46	0.53	14.12	0.63	15.48	18.14	1.18	1.26	1.18	18.14	0.00	0.00	0.33	0.33	1.69	9.42
IK_62	0.36	10.04	0.43	10.66	13.02	1.78	2.43	1.78	13.02	0.00	0.00	0.73	0.73	3.70	9.85
IK_63	0.35	11.97	0.44	13.49	15.92	1.05	2.82	1.78	15.42	0.00	0.00	0.56	0.56	2.86	12.59
IK_64	0.37	12.47	0.43	13.69	15.80	1.86	1.91	1.88	15.68	0.00	0.00	0.67	0.67	3.40	13.97
UM_205	0.53	11.32	0.62	11.22	15.75	2.05	2.15	2.15	15.05	0.00	0.00	0.51	0.51	2.15	15.05

UM_214	0.46	13.22	0.57	14.86	18.67	1.44	1.71	1.71	18.51	0.00	0.00	0.40	0.40	1.71	18.51
UM_220	0.19	12.06	0.25	13.38	17.93	1.99	1.98	2.99	16.13	0.00	0.00	0.94	0.94	2.99	16.13
UM_231	0.22	8.90	0.26	9.45	11.30	1.00	2.00	1.99	10.68	0.00	0.00	0.63	0.63	2.00	7.65
UM_232	0.19	9.09	0.24	9.93	13.20	1.03	2.01	2.02	12.38	0.00	0.00	0.94	0.94	3.00	10.71
UM_233	0.29	11.50	0.35	12.36	15.34	0.99	2.15	1.77	14.81	0.00	0.00	0.68	0.68	2.15	12.14
UM_234	0.24	11.33	0.29	12.49	15.62	1.14	2.36	2.05	15.00	0.00	0.00	0.74	0.74	2.36	13.98
KO_372	0.40	11.74	0.54	13.34	16.93	1.74	2.12	1.95	16.24	0.00	0.00	0.51	0.51	2.57	5.44
KO_373	0.61	15.07	0.71	16.21	19.75	1.86	1.93	1.86	19.75	0.00	0.47	0.00	0.47	2.41	4.94
KO_452	0.59	20.38	0.66	21.63	24.42	1.03	1.50	1.22	22.75	0.00	0.00	0.30	0.30	1.54	18.22
KO_454	0.44	19.48	0.50	21.48	24.31	0.80	1.04	1.01	24.24	0.00	0.00	0.27	0.27	1.35	15.77
Specimen1	1.07	15.66	1.13	16.32	18.14	2.66	5.35	5.25	14.93	0.00	0.00	3.39	3.39	5.85	6.11
Specimen2	0.90	14.75	1.05	16.25	19.92	1.76	3.44	1.76	19.92	0.00	3.45	0.00	3.45	5.95	4.98
U2	1.05	40.82	1.23	44.24	61.66	2.31	3.92	3.75	58.45	0.00	2.33	0.00	2.33	5.91	15.14
H-2-1_3	0.40	20.78	0.47	21.98	27.50	1.07	1.97	1.52	26.18	0.00	0.00	0.90	0.90	2.86	10.64
H-2-1_5	0.44	17.19	0.54	18.49	24.54	1.30	1.97	1.81	23.20	0.00	0.00	0.93	0.93	2.96	14.16
HT-2-1_3	0.42	20.05	0.49	21.37	26.77	1.52	2.13	2.01	24.32	0.00	0.00	0.95	0.95	3.02	16.49
HT-2-1_5	0.46	17.56	0.60	20.12	24.59	1.35	2.48	2.02	22.65	0.00	0.00	0.97	0.97	3.08	14.47
3CMD12	0.54	64.29	0.62	70.32	80.03	1.02	1.74	1.26	75.31	2.42	0.00	2.62	2.42	2.08	33.50
Unit_6	0.39	34.81	0.48	38.39	48.94	1.99	5.31	3.01	46.20	0.00	0.00	2.51	2.51	5.31	43.07
SRC	0.15	101.48	0.22	111.76	128.50	0.89	1.27	0.89	128.50	0.00	0.00	1.38	1.38	2.34	37.23
A4	0.60	32.22	0.73	36.72	41.61	1.47	2.54	2.92	35.22	0.00	0.00	0.89	0.89	3.49	26.98
FS0	0.69	34.17	0.85	35.11	46.29	2.14	5.45	2.14	46.29	3.22	0.00	0.00	3.22	9.10	4.95
FS1	0.73	35.22	0.87	37.84	45.21	3.30	5.33	3.30	45.21	2.98	0.00	0.00	2.98	8.40	7.87
CUW	0.00	0.00	0.00	0.00	59.16	1.37	1.75	1.88	57.39	0.00	0.94	0.00	0.94	2.62	14.76
I18	0.00	0.00	0.00	0.00	88.33	1.40	1.98	1.40	88.33	0.00	1.11	0.00	1.11	2.82	19.35
I21	0.00	0.00	0.00	0.00	95.71	0.72	1.67	1.09	92.62	0.00	0.00	1.24	1.24	3.14	28.63
C1	0.00	0.00	0.00	0.00	36.19	0.38	0.57	0.38	36.19	0.35	0.00	0.00	0.35	1.00	8.32
C4	0.00	0.00	0.00	0.00	38.49	0.49	1.33	0.70	38.40	1.42	0.00	0.00	1.42	4.00	7.39
C8	0.00	0.00	0.00	0.00	52.85	0.62	1.04	0.62	52.85	0.53	0.00	0.00	0.53	1.50	19.48
C12	0.00	0.00	0.00	0.00	48.67	0.73	1.52	0.88	48.20	2.87	0.00	0.00	2.87	8.10	1.50
D1	0.00	0.00	0.00	0.00	73.53	0.60	1.17	0.60	73.53	0.97	0.00	0.00	0.97	4.10	7.32

D13	0.00	0.00	0.00	0.00	59.77	0.97	1.43	0.97	59.77	1.24	0.00	0.00	1.24	3.50	0.50
D14	0.00	0.00	0.00	0.00	66.47	1.00	1.92	1.00	66.47	3.58	0.00	0.00	3.58	10.10	5.73
D16	0.00	0.00	0.00	0.00	76.45	0.93	1.80	0.93	76.45	0.95	0.00	0.00	0.95	4.00	12.46
WI_0_033E	1.49	15.90	1.56	16.00	17.81	2.60	2.96	3.01	17.64	0.00	0.00	2.03	2.03	5.87	3.24

Table A-3-3: Extracted data of condition iii rectangular columns

	Based on 0.6 V_{max}		Based on 0.7 V_{max}							Δ at axial failure of column					
Column designation	δ_y (%)	V_y (kips)	δ_y (%)	V_y (kips)	V_{max} (kips)	δ_{vmax} (%)	$\delta_{0.8}$ (%)	δ_S (%)	V_S (kips)	Δ_{bR} (in.)	$\Delta_{b0.25}$ (in.)	Δ_{bmax} (in.)	Δ_{bP} (in.)	δ_{bp}(%)	V_{bP} (kips)
WI_40_033aE	0.63	16.19	0.86	19.11	22.20	3.61	3.63	3.61	22.20	0.00	0.00	1.16	1.16	3.35	8.08
WI_40_033aW	0.49	13.80	0.72	17.05	22.77	2.64	3.52	2.64	22.77	0.00	0.00	1.21	1.21	3.52	9.55
WI_40_033_E	1.25	16.75	1.42	18.10	21.18	2.58	5.02	3.92	19.67	0.00	0.00	1.78	1.78	5.17	15.19
WI_40_033_W	1.26	18.43	1.48	20.68	23.58	2.66	4.11	2.66	23.58	0.00	0.00	1.93	1.93	5.59	22.43
UM_207	0.49	16.08	0.70	18.89	24.00	1.29	1.61	1.29	24.00	0.00	0.00	0.31	0.31	1.99	10.86
BR-S1	0.39	91.12	0.45	95.85	132.70	0.93	1.09	1.62	111.40	0.00	1.13	0.00	1.13	1.93	33.18
UnitR1A	0.44	99.50	0.46	104.00	127.90	1.39	1.43	1.39	127.90	0.00	0.00	1.42	1.42	1.48	71.72
3CMH18	0.39	53.49	0.46	59.72	73.73	0.92	1.03	0.92	73.74	2.40	2.40	0.00	2.40	2.07	18.77
3SLH18	0.46	47.56	0.49	49.52	60.70	0.76	1.05	0.76	60.70	3.61	3.61	0.00	3.61	3.11	2.90
Unit_7	0.42	35.09	0.49	37.64	47.59	0.98	2.04	1.67	45.70	0.00	0.00	0.96	0.96	2.04	42.78
RRC	0.25	84.53	0.44	99.81	116.24	1.00	1.21	1.00	116.24	0.00	0.00	0.76	0.76	1.29	83.67
C1	0.49	21.58	0.66	22.93	28.15	1.02	1.49	1.17	26.59	0.00	0.00	0.82	0.82	1.98	13.32
UNIT_1	0.00	0.00	0.00	0.00	105.95	0.85	2.26	0.85	105.95	0.00	0.00	1.47	1.47	2.26	82.46
OA2	0.00	0.00	0.00	0.00	29.35	0.85	1.47	0.99	28.76	0.00	0.00	0.32	0.32	1.81	12.37
OA5	0.00	0.00	0.00	0.00	30.11	0.34	1.03	0.34	30.11	0.00	0.00	0.22	0.22	1.26	15.46
CUS	0.00	0.00	0.00	0.00	72.53	1.10	1.31	1.10	72.53	0.00	1.20	0.00	1.20	3.36	13.89
UNIT_1_1	0.00	0.00	0.00	0.00	48.02	0.93	1.50	0.97	46.51	0.00	0.00	0.54	0.54	1.50	28.06
SC3	0.00	0.00	0.00	0.00	101.19	1.76	2.28	1.76	101.19	0.00	0.00	1.32	1.32	2.76	30.68
SC9	0.00	0.00	0.00	0.00	144.49	0.73	0.89	0.73	144.49	0.00	0.00	1.03	1.03	2.14	36.87
UnitR3A	0.00	0.00	0.00	0.00	141.10	0.95	1.00	0.95	141.10	0.00	1.48	0.00	1.48	1.54	30.75
UnitR5A	0.00	0.00	0.00	0.00	169.70	0.50	0.65	0.61	165.90	0.00	1.35	0.00	1.35	1.41	42.77
Specimen_B1	0.00	0.00	0.00	0.00	30.56	1.38	1.50	1.13	25.83	0.00	0.00	0.62	0.62	1.98	16.06
Specimen_CE	0.00	0.00	0.00	0.00	21.74	0.37	0.48	0.38	21.74	0.00	0.00	0.07	0.07	0.53	11.35
Specimen_BE	0.00	0.00	0.00	0.00	21.52	0.27	0.43	0.34	20.26	0.00	0.00	0.09	0.09	0.68	10.48
Specimen_LE	0.00	0.00	0.00	0.00	36.91	0.63	1.27	1.04	32.83	0.00	0.00	0.26	0.26	1.85	18.96

No.1	0.00	0.00	0.00	0.00	53.28	0.99	1.00	0.99	53.28	6.33	0.00	0.00	6.33	13.40	0.00
No.3	0.00	0.00	0.00	0.00	51.55	0.91	0.79	0.91	51.55	0.95	0.00	0.00	0.95	2.00	2.25
No.4	0.00	0.00	0.00	0.00	58.67	1.02	0.81	1.02	58.67	0.95	0.00	0.00	0.95	2.00	0.00
D11	0.00	0.00	0.00	0.00	55.03	0.50	0.84	0.50	55.03	0.67	0.00	0.00	0.67	1.90	2.50
D12	0.00	0.00	0.00	0.00	56.40	0.46	0.97	0.46	56.40	0.67	0.00	0.00	0.67	1.90	2.62
N-18M	0.00	0.00	0.00	0.00	61.03	0.70	0.94	0.70	61.03	3.61	0.00	0.00	3.61	10.20	15.38
N-27C	0.00	0.00	0.00	0.00	59.12	0.48	0.75	0.52	58.11	1.06	0.00	0.00	1.06	3.00	0.66
N-27M	0.00	0.00	0.00	0.00	65.62	0.70	1.24	0.70	65.62	1.67	0.00	0.00	1.67	4.70	0.57
S-1	0.00	0.00	0.00	0.00	88.08	1.41	2.00	1.41	88.08	3.05	0.00	0.00	3.05	8.60	9.22
3CLH18	0.65	54.96	0.68	56.20	62.27	1.05	1.05	1.05	62.27	2.40	0.00	0.00	2.40	2.07	2.50
A1	0.77	35.74	0.83	37.47	41.99	1.49	1.45	1.49	41.99	0.00	0.00	0.65	0.65	2.54	19.86

Table A-3-4: Extracted data of condition i circular columns

	Based on 0.6 V_{max}		Based on 0.7 V_{max}							Δ at axial failure of column					
Column designation	δ_y (%)	V_y (kips)	δ_y (%)	V_y (kips)	V_{max} (kips)	δ_{vmax} (%)	$\delta_{0.8}$ (%)	δ_S (%)	V_S (kips)	Δ_{bR} (in.)	$\Delta_{b0.25}$ (in.)	Δ_{bmax} (in.)	Δ_{bP} (in.)	δ_{bp} (%)	V_{bP} (kips)
No.1	0.89	24.60	0.94	25.11	31.10	4.17	4.16	5.55	29.41	0.00	0.00	5.97	5.97	5.55	29.41
No. 2	2.25	6.70	2.41	6.98	8.23	4.80	5.36	4.80	8.23	0.00	0.00	4.12	4.12	7.81	5.93
No.3	0.64	13.28	0.74	14.04	17.56	4.36	4.34	4.36	17.56	0.00	0.00	1.59	1.59	4.34	16.81
No.2	0.46	29.55	0.54	31.15	36.74	1.20	1.60	1.20	36.74	0.00	0.00	1.94	1.94	3.08	12.28
No.5A	0.37	147.21	0.39	151.49	182.48	1.19	2.31	2.39	163.97	0.00	0.00	1.13	1.13	2.39	163.97
No.5B	1.33	206.91	1.44	208.44	210.65	1.75	2.59	1.97	205.97	0.00	0.00	1.22	1.22	2.59	147.45
No.5	0.52	25.42	0.62	27.93	32.00	1.41	4.17	2.02	30.90	0.00	0.00	3.65	3.65	5.80	9.89
No.6	0.44	35.51	0.34	32.65	39.37	1.08	2.44	1.34	39.03	0.00	0.00	2.34	2.34	3.71	15.13
No.10	0.54	39.08	0.59	40.88	47.72	1.18	2.02	1.91	42.89	0.00	0.00	1.30	1.30	2.06	17.00
No.11	0.49	37.79	0.56	40.58	46.41	0.97	1.50	0.97	46.41	0.00	1.43	0.00	1.43	2.26	11.60
M1E1	0.49	5.51	0.59	6.36	7.55	1.59	2.58	1.59	7.55	0.00	0.00	2.71	2.71	3.60	2.30
M1E2	0.38	5.80	0.48	6.71	8.31	1.22	2.38	1.22	8.31	0.00	0.00	2.07	2.07	2.75	4.08
Con1	2.05	3.48	2.28	3.70	4.28	3.77	6.32	3.77	4.28	0.00	0.00	3.57	3.57	7.96	2.17
Con2	1.84	7.71	2.08	8.54	9.30	3.91	8.01	8.03	8.27	0.00	0.00	1.80	1.80	8.03	8.28
Con3	1.61	7.75	1.92	8.69	9.67	3.97	7.85	5.20	9.48	0.00	0.00	1.79	1.79	7.99	7.88
NIST, Full scale Flexure	1.14	244.05	1.20	251.51	290.76	1.94	5.77	3.90	288.60	0.00	0.00	23.36	23.36	6.49	103.63
NIST Ful sclae shear	1.01	558.00	1.07	576.71	737.79	3.18	7.78	3.18	737.79	0.00	0.00	14.02	14.02	7.79	258.79
NIST Model N1	0.77	10.82	0.85	11.63	14.41	2.30	7.96	8.21	12.83	0.00	0.00	3.25	3.25	11.00	7.35
NIST Model N2	0.70	13.58	0.77	14.54	16.51	1.82	7.15	4.89	15.73	0.00	0.00	2.90	2.90	9.81	4.70
NIST Model N3	0.99	5.66	1.08	5.90	7.17	3.61	6.72	7.38	6.81	0.00	0.00	4.36	4.36	7.38	2.15

NIST Model N4	0.52	11.22	0.61	12.87	14.10	2.39	7.29	5.68	13.79	0.00	2.56	0.00	2.56	8.68	3.26
NIST Model N5	0.69	13.61	0.91	16.26	17.21	2.71	6.82	5.52	16.32	0.00	0.00	2.53	2.53	8.57	6.02
NIST Model N6	0.82	5.68	0.89	6.05	6.67	2.01	4.75	4.61	6.60	0.00	0.00	4.61	4.61	7.81	1.97
BRI No.2	0.28	18.92	0.37	20.48	27.96	2.87	2.23	3.11	26.25	0.00	0.00	1.06	1.06	3.59	11.33
BRI No.3 ws27bs	0.56	24.54	0.72	27.19	33.25	1.98	5.77	1.98	33.26	0.00	0.00	3.29	3.29	8.37	19.67
A2	1.07	13.73	1.20	14.87	16.63	3.64	5.63	5.63	15.03	0.00	0.00	3.04	3.04	5.63	13.45
A3	1.01	13.70	1.13	14.42	16.93	5.31	11.47	5.31	16.93	0.00	0.00	6.20	6.20	11.47	15.41
A4	1.08	13.31	1.19	13.96	16.97	4.13	4.12	4.13	16.97	0.00	0.00	2.31	2.31	4.27	15.45
A5	1.36	14.55	1.48	15.43	20.86	5.41	5.45	5.41	20.86	0.00	0.00	2.95	2.95	5.45	12.88
A6	1.04	13.90	1.15	14.62	17.26	3.67	6.84	3.67	17.26	0.00	0.00	3.76	3.76	6.96	6.50
A7	0.88	13.87	1.02	14.91	17.75	2.43	4.21	2.43	17.75	0.00	0.00	3.13	3.13	5.79	13.93
A8	1.04	12.90	1.11	13.38	16.42	3.21	5.79	4.49	16.19	0.00	0.00	3.13	3.13	5.79	13.79
A9	0.84	13.24	0.99	14.65	16.86	2.72	5.56	6.60	15.41	0.00	0.00	3.56	3.56	6.60	15.41
A10	0.93	13.29	1.06	14.51	16.69	2.37	6.61	6.61	14.24	0.00	0.00	3.57	3.57	6.61	14.24
A11	0.85	12.27	0.96	13.11	16.30	2.59	5.88	3.92	15.13	0.00	0.00	4.02	4.02	7.45	15.05
A12	0.81	12.79	0.95	13.94	16.25	3.18	7.47	4.21	15.95	0.00	0.00	4.03	4.03	7.47	12.06
SRPH1	1.34	68.43	1.47	72.42	81.75	8.45	8.72	8.45	81.75	0.00	0.00	12.56	12.56	8.72	44.55
NH6	1.47	183.58	1.86	206.90	249.30	7.62	9.47	9.50	246.38	0.00	0.00	6.87	6.87	9.58	173.05
FL1	1.75	29.44	1.83	30.46	42.04	6.70	9.08	7.99	40.78	0.00	0.00	13.08	13.08	9.09	26.69
FL2	1.72	32.60	1.84	34.12	39.28	3.72	5.58	5.24	38.77	0.00	0.00	8.27	8.27	5.74	28.49
415	0.79	52.29	0.87	55.61	64.07	5.09	6.29	5.95	61.37	0.00	0.00	7.05	7.05	7.34	16.55
815	1.67	28.99	1.72	29.20	33.94	8.90	8.90	8.90	33.94	0.00	0.00	17.13	17.13	8.92	12.70
1015	1.55	18.05	1.74	19.17	22.82	3.07	10.50	10.21	22.04	0.00	0.00	25.05	25.05	10.44	17.69
407	0.48	31.41	0.62	36.71	40.46	1.45	4.92	3.10	40.01	0.00	0.00	5.04	5.04	5.25	27.88
430	1.22	86.91	1.37	92.12	107.90	7.14	7.30	7.14	107.90	0.00	0.00	7.13	7.13	7.42	37.54
328	0.79	99.08	0.92	108.93	124.76	6.73	7.24	6.73	124.76	0.00	0.00	5.24	5.24	7.27	59.35
828	1.76	38.76	1.82	39.67	45.63	9.00	15.63	15.62	37.34	0.00	0.00	30.00	30.00	15.62	37.34
1028	2.00	36.09	2.14	37.79	42.80	14.25	14.46	14.25	42.80	0.00	0.00	35.00	35.00	14.58	11.90

IC3	1.02	82.12	1.07	83.71	103.48	5.04	8.27	8.10	99.41	0.00	0.00	5.93	5.93	8.36	30.42
RC1	0.77	11.66	0.95	12.76	15.97	2.35	9.15	9.13	12.83	0.00	0.00	5.91	5.91	9.13	13.56
RC2	0.77	11.45	0.94	12.46	15.35	2.25	7.44	7.44	13.70	0.00	0.00	4.82	4.82	7.44	13.70
RC3	1.01	14.88	1.10	15.38	18.38	1.05	6.14	3.61	17.00	0.00	0.00	3.98	3.98	6.15	13.66
RC4	0.88	14.48	1.02	14.88	19.16	2.19	3.28	2.63	17.33	0.00	2.86	0.00	2.86	4.41	4.79
RC6	0.82	14.59	0.72	15.48	17.63	3.10	3.21	4.16	16.05	0.00	0.00	2.69	2.69	4.16	16.05
RC7	0.99	12.86	1.11	13.66	16.60	3.43	8.62	8.62	13.37	0.00	0.00	5.58	5.58	8.62	13.37
RC8	0.88	14.90	0.97	15.93	18.28	2.77	4.61	3.94	16.55	0.00	0.00	2.87	2.87	4.43	10.66
RC9	0.73	16.34	0.86	17.80	21.58	2.62	6.60	6.60	18.32	0.00	0.00	4.28	4.28	6.60	18.32
415p	1.06	59.27	1.22	64.06	74.19	5.22	7.32	5.22	74.19	0.00	0.00	7.03	7.03	7.32	32.24
C1	1.38	21.58	1.50	23.00	26.59	4.18	9.92	10.08	26.36	0.00	0.00	7.81	7.81	10.07	10.59
C2	1.10	20.46	1.23	21.01	27.21	11.36	11.35	11.36	27.21	0.00	0.00	8.74	8.74	11.27	11.55
C3	0.88	26.44	0.95	27.92	30.69	2.84	10.06	4.24	30.67	0.00	0.00	7.80	7.80	10.06	24.41
C4	0.57	28.72	0.66	31.15	38.28	1.91	8.64	2.34	36.04	0.00	6.73	0.00	6.73	8.68	9.57
C5	0.68	31.40	0.77	33.37	41.29	1.74	3.13	2.11	39.57	0.00	0.00	8.64	8.64	11.15	20.90
C6	0.62	30.38	0.72	32.78	40.83	1.68	2.89	2.09	39.42	0.00	7.33	0.00	7.33	9.45	10.20
C7	0.69	29.89	0.80	32.49	39.92	2.07	3.03	2.44	39.03	0.00	6.96	0.00	6.96	8.98	10.00
C8	0.68	32.01	0.78	34.20	44.59	2.09	3.09	2.46	43.28	0.00	0.00	7.42	7.42	9.58	12.82
1	1.51	30.24	1.59	31.88	34.86	2.16	7.54	7.04	31.62	0.00	0.00	7.50	7.50	7.81	26.19
2	1.72	30.95	1.91	34.00	35.80	4.44	10.58	10.94	21.30	0.00	0.00	10.50	10.50	10.94	21.30
3	1.98	37.59	2.06	38.24	43.08	9.66	10.49	10.45	42.95	0.00	0.00	10.25	10.25	10.68	29.32
4	1.67	30.17	1.75	30.94	35.32	8.66	13.14	13.11	34.36	0.00	0.00	7.73	7.73	8.05	28.00
UC1	0.98	13.01	1.02	13.43	15.81	2.99	6.08	5.93	14.82	0.00	0.00	4.44	4.44	6.08	10.40
UC2	1.07	13.85	1.14	14.42	16.96	6.50	6.96	6.68	16.92	0.00	0.00	6.53	6.53	8.94	11.15
UC3	1.41	17.97	1.61	18.51	23.83	8.14	11.06	9.17	23.15	0.00	0.00	9.49	9.49	13.00	9.28
Unit No.3 (Potangaroa)	0.34	132.32	0.37	136.63	165.00	1.28	1.39	1.42	158.71	0.00	0.00	0.65	0.65	1.39	158.71
M2E1	0.47	14.14	0.50	14.87	19.32	1.81	3.49	2.84	15.44	0.00	0.00	1.24	1.24	3.50	12.93
M2E2	0.42	14.40	0.50	16.31	20.90	1.78	4.01	2.69	18.70	0.00	0.00	1.42	1.42	4.03	9.67
ws21bs	0.43	30.28	0.52	33.09	41.32	2.02	3.10	2.10	39.30	0.00	0.00	1.64	1.64	8.33	18.54
ws25bs	0.60	32.18	0.81	38.54	41.59	1.73	3.57	2.76	38.64	0.00	0.00	1.50	1.50	7.60	16.43

Table A-3-5: Extracted data of condition ii circular columns

	Based on 0.6 V_{max}		Based on 0.7 V_{max}							Δ at axial failure of column					
Column designation	δ_y (%)	V_y (kips)	δ_y (%)	V_y (kips)	V_{max} (kips)	δ_{vmax} (%)	$\delta_{0.8}$ (%)	δ_S (%)	V_S (kips)	Δ_{bR} (in.)	$\Delta_{b0.25}$ (in.)	Δ_{bmax} (in.)	Δ_{bP} (in.)	δ_{bp} (%)	V_{bP} (kips)
No. 1	0.92	33.61	1.04	35.71	44.01	4.41	4.82	3.00	43.05	0.00	0.00	4.66	4.66	5.92	31.26
No. 2	0.85	63.52	0.89	64.76	77.04	3.01	1.29	5.00	72.73	0.00	0.00	3.94	3.94	5.00	72.73
No.3	0.99	27.72	1.04	28.37	34.57	1.80	5.71	4.25	34.10	0.00	0.00	4.58	4.58	5.81	18.45
No.1	0.44	23.96	0.53	26.19	31.31	1.24	3.72	3.72	28.03	0.00	0.00	2.34	2.34	3.72	28.03
No.1	0.39	117.98	0.45	123.33	154.47	1.69	3.49	3.54	148.13	0.00	0.00	1.67	1.67	3.54	148.14
No.4	0.40	134.68	0.47	142.79	175.54	1.39	2.73	2.73	148.34	0.00	0.00	1.29	1.29	2.73	148.34
No.9	1.72	76.73	1.74	77.53	88.30	5.91	6.51	5.91	88.30	0.00	0.00	2.57	2.57	6.53	50.28
No.1	0.88	89.08	0.89	89.10	103.69	3.51	5.08	4.64	97.27	1.58	0.00	0.00	1.58	5.02	66.45
No.3	0.78	98.95	0.99	115.53	130.07	2.50	3.46	3.43	124.22	0.00	0.00	1.33	1.33	4.24	56.95
BRI No.3 ws22bs	0.35	16.90	0.45	18.69	23.08	1.18	4.85	1.78	22.94	0.00	0.00	1.97	1.97	4.99	13.90
No.16	0.67	32.30	0.75	34.81	39.77	3.20	3.42	3.42	38.42	0.00	0.00	1.21	1.21	3.42	38.42
No.20	0.59	36.93	0.71	40.68	47.71	1.56	3.44	3.50	45.38	0.00	0.00	1.24	1.24	3.50	45.38
NH1	0.79	110.79	0.84	115.49	139.38	3.64	5.07	3.63	130.86	0.00	0.00	3.63	3.63	5.07	79.49
NH3	0.80	97.00	0.96	109.05	124.00	5.45	5.53	5.45	124.00	0.00	0.00	3.95	3.95	5.51	89.67
FL3	1.70	31.21	1.84	32.90	44.38	8.70	9.30	8.70	44.38	0.00	0.00	13.38	13.38	9.30	25.18
IC1	1.23	73.66	1.43	81.89	97.48	5.67	7.59	5.67	97.48	0.00	0.00	5.38	5.38	7.59	38.66
B105IC2	0.92	71.85	1.17	81.40	96.79	4.84	6.63	6.68	94.56	0.00	0.00	4.75	4.75	6.70	52.07
Col 1	0.63	52.88	0.75	55.83	69.32	2.81	3.52	2.81	69.32	2.12	0.00	0.00	2.12	3.53	55.12
Col 2	0.56	50.11	0.66	53.30	65.95	1.64	3.54	1.64	65.95	3.54	0.00	0.00	3.54	5.90	4.40
Col 3	0.52	48.09	0.59	50.99	61.89	1.81	3.75	2.84	57.83	2.28	0.00	2.28	2.28	3.80	16.15
Col 4	0.46	46.17	0.65	56.30	59.64	2.12	2.97	2.86	58.87	1.80	0.00	1.73	1.80	3.00	30.85
415s	1.06	53.29	1.20	58.60	64.80	5.25	5.27	5.25	64.80	0.00	0.00	7.09	7.09	7.39	26.55
Test3	0.67	41.36	0.78	44.63	55.74	3.01	3.75	3.62	53.33	0.00	0.00	5.42	5.42	3.77	29.02
1	0.76	18.55	0.87	19.83	23.87	1.90	3.82	2.71	23.66	0.00	0.00	4.39	4.39	3.89	8.05

Unit No.8	1.90	94.85	1.88	94.14	104.54	3.23	5.49	4.52	96.05	0.00	0.00	1.72	1.72	5.45	48.03
Unit No.10	1.96	90.85	2.02	92.15	101.39	3.20	4.86	4.37	96.35	0.00	0.00	1.61	1.61	5.10	28.03
Unit No.15	0.77	40.09	0.93	45.03	51.78	3.31	5.10	3.31	51.78	0.00	0.00	1.56	1.56	4.94	15.52
ws26bs	0.63	19.36	0.69	20.59	23.52	1.71	4.56	4.66	21.96	0.00	0.00	1.84	1.84	4.69	19.81
Unit No.23	0.58	36.38	0.71	39.86	47.70	1.50	2.79	1.50	47.70	0.00	0.00	1.23	1.23	3.91	29.87
NR 1	0.28	66.15	0.36	76.03	94.05	3.00	3.31	3.00	94.05	0.00	0.00	0.96	0.96	2.66	82.86
NH2	1.01	52.36	1.07	54.29	63.66	2.38	2.41	2.57	56.45	0.00	0.00	1.84	1.84	2.57	56.45
NH4	1.63	184.25	1.89	204.33	221.45	9.25	9.42	9.25	221.45	0.00	0.00	6.93	6.93	9.67	122.29
NH5	1.24	67.91	1.43	74.43	89.52	6.09	7.83	6.21	83.54	0.00	0.00	5.62	5.62	7.84	44.51
UC15	0.80	32.86	0.81	33.21	39.24	2.43	4.08	4.05	37.50	0.00	0.00	1.68	1.68	4.08	27.75
Specimen S1	0.32	34.53	0.44	39.22	48.31	1.63	3.77	3.06	46.05	2.75	0.00	2.38	2.75	4.58	4.63
Specimen S3	0.53	44.10	0.67	49.50	59.87	2.80	3.54	2.80	59.87	2.88	0.00	0.00	2.88	4.80	7.26
Specimen C2	0.48	46.98	0.56	50.86	62.06	1.87	3.77	3.00	57.89	2.27	0.00	0.00	2.27	3.79	15.31
Specimen C3R	0.35	43.36	0.59	55.78	59.99	1.73	2.96	2.91	58.70	1.75	0.00	0.00	1.75	2.92	20.26
Specimen S3	0	0	0	0	17.34	2.49	2.47	2.49	17.34	0.00	1.32	0.00	1.32	3.30	4.34

Table A-3-6: Extracted data of condition iii circular columns

	Based on 0.6 V_{max}		Based on 0.7 V_{max}							Δ at axial failure of column					
Column designation	δ_y (%)	V_y (kips)	δ_y (%)	V_y (kips)	V_{max} (kips)	δ_{vmax} (%)	$\delta_{0.8}$ (%)	δ_S (%)	V_S (kips)	Δ_{bR} (in.)	$\Delta_{b0.25}$ (in.)	Δ_{bmax} (in.)	Δ_{bP} (in.)	δ_{bp} (%)	V_{bP} (kips)
No.21	0.61	27.11	0.77	30.96	34.67	1.82	3.65	3.68	33.19	0.00	0.00	1.74	1.74	3.68	33.19
No.26	0.57	29.78	0.65	31.66	39.15	1.66	3.65	3.63	34.95	0.00	0.00	1.72	1.72	3.63	34.95
Unit No.1	2.34	71.05	2.35	71.27	72.25	2.91	4.31	4.08	65.34	0.00	0.00	1.31	1.31	4.15	31.18
Unit No.2	0.75	47.54	0.78	49.05	49.61	0.96	3.90	3.85	48.47	0.00	0.00	1.22	1.22	3.88	26.77
Unit No.3	3.61	58.26	3.63	58.52	62.09	4.00	4.03	4.00	62.09	0.00	0.00	1.57	1.57	3.99	35.19
Unit No.5	2.57	73.61	2.51	73.29	74.39	2.74	3.85	3.85	72.01	0.00	0.00	1.23	1.23	3.91	48.01
Unit No.11	1.88	85.09	1.93	86.66	91.52	2.14	2.22	2.13	91.52	0.00	1.01	0.00	1.01	3.21	21.91
Unit No.12	2.22	116.97	2.19	116.31	118.44	2.31	3.01	2.94	115.90	0.00	0.00	1.26	1.26	5.32	40.99
Unit No.13	1.22	81.21	1.34	84.99	98.99	4.04	4.37	4.37	98.08	0.00	0.00	2.05	2.05	6.52	37.38
Unit No.14	1.02	60.03	1.11	63.69	71.12	2.15	4.37	3.04	68.82	0.00	0.00	1.38	1.38	4.39	26.96
Unit No.17	0.98	55.56	1.21	65.49	73.12	1.78	2.85	2.22	65.09	0.00	0.00	1.81	1.81	4.61	22.29
Unit No.23	1.13	62.35	1.33	70.14	74.75	2.11	4.05	4.07	72.61	0.00	0.00	1.27	1.27	4.04	26.18
Unit No.24	0.97	61.47	1.08	64.78	76.54	4.02	4.05	4.02	76.54	0.00	0.00	1.88	1.88	5.96	20.96
Unit No.2 (Wong)	0.47	84.60	0.55	91.58	109.99	1.40	1.88	1.40	110.00	0.00	0.00	0.91	0.91	2.88	60.93
Unit No.10	0.38	42.18	0.52	49.40	57.15	1.32	2.68	1.67	55.56	0.00	0.00	0.79	0.79	3.34	38.15
Unit No.15	0.68	31.01	0.80	34.75	40.38	1.57	2.77	1.57	40.38	0.00	0.00	1.23	1.23	3.47	26.19
NR2	0.43	100.21	0.52	114.54	132.04	1.68	1.70	1.73	120.74	0.00	0.00	0.76	0.76	2.11	35.04
UC13	0.43	26.94	0.47	28.18	32.21	0.68	1.08	0.68	32.21	0.00	0.00	0.66	0.66	1.59	13.77
UC14	0.75	33.15	0.81	35.46	36.96	1.03	1.32	1.03	36.96	0.00	0.00	0.57	0.57	1.38	17.17
CCS1	0.43	99.12	0.48	105.60	124.20	0.87	1.19	1.15	123.40	0.00	0.00	1.20	1.20	1.25	45.38
I 30	0.57	69.82	0.70	79.17	91.37	1.10	1.85	1.10	91.37	0.00	0.00	1.08	1.08	2.75	28.34
UNIT 4	0	0	0	0	65.01	1.67	2.54	2.26	63.092	0.00	0.00	0.81	0.81	2.56	46.84
UNIT 6	0	0	0	0	88.04	1.70	1.70	1.70	88.043	0.00	0.00	0.61	0.61	2.57	43.84
UNIT 7	0	0	0	0	63.09	1.50	3.97	1.50	63.092	0.00	0.00	1.26	1.26	4.02	20.55
UNIT 16	0	0	0	0	83.68	1.54	1.55	1.54	83.68	0.00	1.22	0.00	1.22	3.86	19.90

UNIT 18	0	0	0	0	113.49	1.77	1.92	1.77	113.49	0.00	0.00	1.08	1.08	3.43	29.22
UNIT 19	0	0	0	0	98.34	1.46	1.72	1.46	98.34	0.00	0.00	1.04	1.04	4.39	26.48
UNIT 20	0	0	0	0	109.40	1.79	1.94	1.79	109.4	0.00	1.22	0.00	1.22	4.44	27.35
UNIT 21	0	0	0	0	60.80	1.33	3.52	1.33	60.8	0.00	0.00	1.45	1.45	4.60	16.43
UNIT 22	0	0	0	0	64.03	1.51	1.64	1.51	64.03	0.00	0.00	1.33	1.33	4.22	16.42
UNIT 1	0	0	0	0	39.65	0.98	2.01	0.98	39.646	0.00	0.00	0.79	0.79	3.35	20.01
UNIT 2	0	0	0	0	45.82	1.28	2.64	1.95	43.475	0.00	0.00	0.79	0.79	3.34	31.86
UNIT 4	0	0	0	0	44.01	0.64	1.57	0.93	43.025	0.00	0.00	0.64	0.64	2.69	19.79
UNIT 6	0	0	0	0	50.65	0.99	1.99	1.31	49.789	0.00	0.00	0.79	0.79	3.34	28.15
UNIT 8	0	0	0	0	48.53	0.99	2.30	1.61	46.185	0.00	0.00	0.79	0.79	3.33	29.76
UNIT 9	0	0	0	0	51.26	0.96	2.03	1.30	50.525	0.00	0.00	0.80	0.80	3.37	30.37
UNIT 12	0	0	0	0	43.15	0.62	1.14	0.62	43.15	0.00	0.00	0.64	0.64	2.72	18.93
UNIT 13	0	0	0	0	53.60	0.95	1.65	0.95	53.597	0.00	0.00	0.78	0.78	3.30	23.73
UNIT 14	0	0	0	0	62.74	1.28	2.01	1.28	62.74	0.00	0.00	0.80	0.80	3.38	31.50
UNIT 17	0	0	0	0	55.43	0.97	1.97	0.97	55.431	0.00	0.00	0.64	0.64	2.69	36.22
UNIT 19	0	0	0	0	41.92	1.10	2.41	1.33	41.552	0.00	0.00	1.24	1.24	3.50	24.59
UNIT 22	0	0	0	0	38.47	1.28	2.12	1.28	38.475	0.00	0.00	1.22	1.22	3.45	19.18
UNIT 24	0	0	0	0	52.61	0.96	1.69	0.96	52.615	0.00	0.00	0.64	0.64	2.69	28.52
UNIT 25	0	0	0	0	45.24	1.13	2.00	1.13	45.239	0.00	0.00	1.11	1.11	3.14	21.27
UNIT 27	0	0	0	0	39.58	1.11	1.79	1.11	39.583	0.00	0.00	1.11	1.11	3.13	18.19
UNIT 28	0	0	0	0	51.88	1.11	1.79	1.11	51.877	0.00	0.00	1.23	1.23	3.47	23.23
UNIT S-1	0	0	0	0	91.15	1.94	2.39	2.43	87.195	0.00	0.00	1.16	1.16	2.41	24.13
UNIT S1-2	0	0	0	0	74.70	0.74	0.90	0.71	70.25	0.00	0.00	0.47	0.47	0.97	29.09
UNIT S2	0	0	0	0	74.70	0.71	0.88	0.84	74.409	0.00	0.00	0.55	0.55	1.14	32.21
Unit CS-A1	0	0	0	0	102.10	0.36	0.53	0.40	100.7	0.00	0.00	0.63	0.63	0.65	32.81
Unit CS-A	0	0	0	0	192.07	6.26	6.78	6.26	192.07	0.00	0.00	5.31	5.31	7.37	131.19
Specimen BR-C1	0	0	0	0	126.45	1.48	1.75	1.48	126.45	0.00	0.00	1.40	1.40	2.40	53.40
Specimen S1	0	0	0	0	17.84	2.22	2.52	2.22	17.84	0.00	1.02	0.00	1.02	2.56	4.46
Specimen CR-C	0	0	0	0	95.23	0.83	0.87	0.83	95.225	0.00	0.94	0.00	0.94	1.58	23.81

Table A-3-7: Additional calculated data of condition i rectangular columns

Column designation	V_P (kips)	V_o (kips)	a	b_P	b_R
No.1	124.48	227.10	0.023	0.023	0.000
No.2	167.60	346.63	0.017	0.017	0.000
No.3	120.06	249.31	0.014	0.014	0.000
No.4	107.85	374.99	0.010	0.010	0.000
No.3	36.17	149.23	0.026	0.026	0.000
No.4	36.02	107.36	0.030	0.029	0.000
No. 1	41.97	90.09	0.043	0.055	0.055
No. 2	55.76	126.65	0.026	0.048	0.000
No. 3	55.87	100.89	0.023	0.024	0.000
No.7	40.38	136.11	0.047	0.066	0.000
No.8	52.42	183.07	0.062	0.062	0.000
No.5	50.55	134.99	0.018	0.019	0.000
No.6	50.01	95.61	0.012	0.016	0.000
No.7	37.26	187.46	0.007	0.011	0.000
No.8	36.37	145.89	0.008	0.008	0.000
No.9	36.48	286.40	0.024	0.024	0.000
No1	35.17	133.96	0.033	0.074	0.000
No2	35.17	133.96	0.048	0.075	0.000
No3	35.17	133.96	0.030	0.042	0.000
No4	35.17	133.96	0.042	0.068	0.000
No5	81.60	212.86	0.039	0.039	0.000
No6	81.60	212.86	0.061	0.061	0.000
No7	106.67	274.47	0.043	0.044	0.000
No8	106.81	274.56	0.046	0.046	0.000
No9	74.37	209.78	0.104	0.104	0.000
No.102	27.17	63.11	0.015	0.015	0.000
L1	21.34	50.47	0.045	0.045	0.000
L2	21.34	50.47	0.056	0.056	0.000
L3	21.34	50.47	0.040	0.041	0.000
214-08	7.25	30.11	0.014	0.026	0.000
85STC-1	16.87	37.34	0.040	0.064	0.000
85STC-2	14.85	33.62	0.040	0.064	0.000
85STC-3	14.85	33.62	0.040	0.064	0.000
85PDC-1	14.47	26.44	0.016	0.016	0.000
85PDC-2	14.85	33.62	0.020	0.020	0.000
85PDC-3	14.85	33.62	0.023	0.023	0.000
AL-1	39.95	77.01	0.052	0.056	0.000
AH-1	40.93	137.22	0.094	0.094	0.000
AL-2	31.32	84.81	0.015	0.023	0.000
AH-2	31.32	145.02	0.035	0.076	0.000

BH-1	49.07	137.88	0.079	0.080	0.000
BL-2	46.79	86.47	0.028	0.056	0.000
BH-2	46.79	146.66	0.054	0.066	0.000
B2	76.52	141.49	0.035	0.035	0.000
B4	76.52	139.28	0.014	0.035	0.000
B5	76.52	165.99	0.012	0.020	0.000
No.1S1	12.35	48.16	0.017	0.017	0.000
No.3S1	12.36	48.18	0.022	0.022	0.000
No.5S1	16.63	53.53	0.021	0.021	0.000
No.9	18.41	55.98	0.014	0.023	0.000
No.11	18.09	53.65	0.015	0.023	0.000
NC 2	85.61	233.99	0.041	0.043	0.000
NC 4	95.27	204.42	0.022	0.022	0.000
U4	62.17	132.46	0.079	0.088	0.000
U6	64.46	119.50	0.074	0.074	0.000
U7	65.15	120.01	0.072	0.073	0.000
BA1	23.26	59.72	0.012	0.025	0.000
BA2	26.25	63.20	0.013	0.025	0.000
BA3	26.25	63.20	0.009	0.022	0.000
BA4	23.25	59.71	0.012	0.032	0.000
CA1	23.25	99.93	0.026	0.051	0.000
CA2	26.25	103.43	0.022	0.040	0.000
CA3	23.25	99.93	0.024	0.044	0.000
CA4	26.25	103.43	0.013	0.045	0.000
BB4	36.62	61.68	0.025	0.052	0.000
BB4B	36.62	61.68	0.032	0.055	0.000
CB1	35.97	97.52	0.039	0.068	0.000
CB2	35.97	97.52	0.042	0.066	0.000
CB3	36.62	100.93	0.039	0.071	0.000
CB4	36.62	100.93	0.041	0.072	0.000
B1	62.64	112.43	0.053	0.063	0.063
B2	70.16	124.67	0.041	0.050	0.050
HC4-8L19-T10-0.1P	67.98	142.55	0.059	0.084	0.084
HC4-8L19-T10-0.2P	77.88	152.75	0.048	0.080	0.000
HC4-8L16-T10-0.1P	59.08	146.25	0.063	0.067	0.000
HC4-8L16-T10-0.2P	71.28	157.34	0.058	0.077	0.000
UC10H	44.01	201.27	0.004	0.006	0.000
UC15H	43.93	268.34	0.014	0.022	0.000
UC20H	43.93	321.26	0.023	0.041	0.000
UC15L	67.99	250.31	0.023	0.068	0.000
UC20L	67.99	303.24	0.032	0.068	0.000

ES-1HT	30.62	149.38	0.012	0.018	0.000
AS-2HT	33.50	152.25	0.021	0.036	0.000
AS-3HT	30.74	156.56	0.015	0.022	0.000
AS-4HT	30.57	222.45	0.019	0.035	0.000
AS-5HT	38.45	251.35	0.004	0.014	0.000
AS-6HT	38.14	290.30	0.011	0.031	0.000
AS-7HT	38.68	158.60	0.008	0.017	0.000
ES-8HT	37.79	312.29	0.007	0.013	0.000
BG-2	31.66	137.60	0.034	0.044	0.000
BG-3	29.94	130.27	0.061	0.061	0.000
BG-5	36.17	174.81	0.051	0.062	0.000
BG-6	36.42	171.65	0.052	0.063	0.000
BG-7	36.69	101.50	0.052	0.062	0.000
BG-8	37.74	94.31	0.059	0.058	0.000
BG-9	37.89	102.08	0.062	0.062	0.000
BG-10	37.32	175.83	0.062	0.062	0.000
C10-10N	19.54	47.36	0.050	0.059	0.000
C10-10S	19.78	47.57	0.051	0.060	0.000
C10-20N	25.04	51.98	0.041	0.052	0.000
C10-20S	26.33	53.92	0.041	0.052	0.000
C5-00N	11.97	40.72	0.047	0.067	0.000
C5-00S	11.69	39.39	0.048	0.068	0.000
C5-40N	18.13	49.83	0.032	0.032	0.000
C5-40S	18.13	49.44	0.032	0.032	0.000
C1-1	46.81	117.74	0.050	0.062	0.000
C1-2	49.69	121.69	0.058	0.064	0.000
C1-3	50.97	124.44	0.045	0.065	0.000
C2-1	46.95	114.37	0.057	0.067	0.000
C2-2	49.96	118.34	0.057	0.065	0.000
C2-3	51.38	121.17	0.040	0.070	0.000
C3-1	47.33	111.51	0.055	0.064	0.000
C3-2	50.18	115.22	0.055	0.068	0.000
C3-3	51.46	117.96	0.047	0.073	0.000
ORC1	44.71	215.54	0.043	0.043	0.000
ORC2	80.89	241.12	0.031	0.039	0.000
ORC3	88.11	247.70	0.022	0.034	0.000
A1	7.07	26.94	0.037	0.037	0.000
A3	13.24	31.62	0.027	0.050	0.000
B1	6.22	29.64	0.038	0.038	0.000
B2	10.17	32.44	0.025	0.055	0.000
B3	13.15	34.97	0.014	0.061	0.000
C1	6.37	44.07	0.046	0.046	0.000
C2	9.91	46.89	0.025	0.060	0.000
C3	12.56	49.30	0.026	0.063	0.000
D1	12.02	40.78	0.018	0.060	0.000

D2	13.02	36.28	0.014	0.061	0.000
D3	11.60	31.22	0.015	0.060	0.000
1006015	28.32	154.27	0.065	0.096	0.000
1006025	35.55	160.81	0.043	0.090	0.000
1006040	35.85	175.72	0.023	0.060	0.000
10013015	28.47	82.43	0.036	0.052	0.000
10013025	36.15	89.17	0.014	0.039	0.000
10013040	37.48	99.29	0.006	0.016	0.000
806040	31.49	177.80	0.077	0.095	0.000
1206040	37.54	185.93	0.051	0.071	0.000
1005540	38.92	253.03	0.043	0.074	0.000
1008040	37.56	184.11	0.019	0.044	0.000
1005552	31.92	318.94	0.027	0.040	0.000
1006052	33.81	207.92	0.027	0.039	0.000
10-3-1.5N	24.50	53.33	0.032	0.033	0.000
10-3-1.5S	24.50	53.33	0.033	0.035	0.000
D1N60	30.73	64.61	0.013	0.023	0.000
L1D60	196.52	570.60	0.021	0.036	0.000
L1N60	199.00	579.96	0.016	0.020	0.000
L1N6B	150.89	501.70	0.011	0.022	0.000
HPRC19-32	22.93	52.16	0.011	0.036	0.000
204-08	7.25	30.11	0.005	0.018	0.000
223-09	5.51	42.83	0.028	0.033	0.000
302-07	6.72	27.32	0.012	0.012	0.000
312-07	6.72	27.32	0.013	0.013	0.000
CA025C	25.80	45.98	0.020	0.025	0.000
CA060C	21.94	54.21	0.007	0.012	0.000
CB060C	74.94	163.20	0.006	0.008	0.000
WI_40_147_E	20.36	50.76	0.041	0.041	0.000
WI_40_147_W	20.36	50.76	0.048	0.048	0.000
WI_40_092_E	20.36	35.82	0.046	0.046	0.000
WI_40_092_W	20.36	35.82	0.042	0.046	0.000
I_25	68.76	182.72	0.020	0.037	0.000
HPRC_1063	19.21	34.22	0.000	0.010	0.000
UNIT_10408	14.15	42.08	0.000	0.010	0.000
UNIT_11408	14.15	42.08	0.000	0.000	0.000
UNIT_12408	14.15	54.09	0.000	0.001	0.000

Table A-3-8: Additional calculated data of condition ii rectangular columns

Column designation	V_P (kips)	V_o (kips)	a	b_P	b_R
No. 4	52.70	72.07	0.016	0.026	0.000
BL-1	49.07	77.69	0.058	0.069	0.000
B1	76.52	117.00	0.014	0.015	0.000
B3	76.40	94.13	0.012	0.010	0.000
B6	76.05	121.11	0.013	0.020	0.000
B7	73.92	111.51	0.007	0.019	0.000
No.2S1	12.44	32.93	0.022	0.022	0.000
No.4S1	13.49	32.55	0.016	0.016	0.000
No.6S1	16.89	37.18	0.021	0.021	0.000
No.10	18.28	39.19	0.017	0.022	0.000
No.12	18.20	37.90	0.016	0.021	0.000
U1	53.36	55.80	0.031	0.067	0.000
U3	62.92	99.66	0.035	0.050	0.000
AA1	26.05	49.80	0.006	0.020	0.000
AA2	26.25	49.80	0.007	0.021	0.000
AA3	23.26	46.31	0.009	0.031	0.000
AA4	23.26	46.31	0.007	0.022	0.000
AB1	35.97	45.18	0.029	0.029	0.000
AB2	36.62	48.59	0.024	0.030	0.000
AB3	36.62	48.59	0.026	0.025	0.000
AB4	35.97	45.18	0.021	0.026	0.000
BB	35.97	58.27	0.035	0.048	0.000
BB1	35.97	58.27	0.020	0.037	0.000
A1	61.89	93.38	0.038	0.056	0.056
A2	68.83	105.17	0.033	0.041	0.041
No.1	12.45	16.81	0.009	0.009	0.000
BG-1	31.66	83.19	0.022	0.022	0.000
BG-4	36.18	101.81	0.025	0.045	0.000
C10-05N	15.70	34.70	0.039	0.072	0.000
C10-05S	15.71	34.75	0.039	0.060	0.000
C5-20N	17.12	35.77	0.030	0.061	0.000
C5-20S	17.00	35.33	0.032	0.062	0.000
10-2-3N	24.59	33.34	0.021	0.023	0.000
10-2-3S	24.59	33.34	0.022	0.022	0.000
10-3-3N	24.37	32.77	0.022	0.023	0.000
10-3-3S	24.37	32.77	0.022	0.022	0.000
10-3-2.25N	24.22	39.10	0.023	0.025	0.000
10-3-2.25S	24.22	39.10	0.025	0.025	0.000
20-3-3N	28.92	36.69	0.026	0.026	0.000
20-3-3S	28.92	36.69	0.025	0.025	0.000

10-2-2.25N	24.66	40.25	0.021	0.023	0.000
10-2-2.25S	24.66	40.25	0.023	0.023	0.000
10-1-2.25N	24.74	40.47	0.024	0.024	0.000
10-1-2.25S	24.74	40.47	0.021	0.022	0.000
D1N30	36.38	55.87	0.020	0.030	0.000
Test 1	32.55	52.70	0.029	0.055	0.000
Test 2	32.53	52.63	0.035	0.044	0.000
Test 3	32.39	52.14	0.053	0.067	0.000
Test 4	32.27	51.73	0.075	0.083	0.000
Test 5	32.63	53.01	0.066	0.071	0.000
Test 6	32.55	52.70	0.078	0.078	0.000
2D16RS	20.82	26.25	0.029	0.035	0.000
4D13RS	24.74	25.92	0.010	0.026	0.000
1007	4.81	9.49	0.018	0.022	0.000
WI_40_048E	19.76	23.56	0.035	0.035	0.000
WI_40_048W	19.76	23.56	0.040	0.042	0.000
WI_25_033_E	18.82	19.12	0.022	0.037	0.000
WI_25_033_W	18.82	19.12	0.024	0.036	0.000
WI_0_048W	15.68	19.94	0.042	0.043	0.000
WI_40_067_E	20.35	29.83	0.053	0.053	0.000
WI_40_067_W	20.35	29.83	0.057	0.057	0.000
2CLH18	50.34	50.43	0.020	0.025	0.025
2CMH18	60.56	61.22	0.004	0.005	0.005
2SLH18	50.34	50.43	0.014	0.031	0.031
3SMD12	74.69	77.84	0.011	0.015	0.015
HC4-8L16-T6-0.1P	59.97	83.24	0.054	0.053	0.000
HC4-8L16-T6-0.2P	72.31	94.48	0.029	0.034	0.000
Specimen_1	64.78	68.72	0.017	0.041	0.041
Specimen_2	59.27	92.02	0.010	0.013	0.013
Specimen_4	65.32	69.14	0.020	0.042	0.042
I_03	22.19	46.57	0.032	0.041	0.000
I_04	26.24	45.72	0.023	0.032	0.000
I_10	31.78	48.65	0.023	0.034	0.000
I_14	31.84	48.94	0.016	0.025	0.000
I_16	31.82	48.87	0.011	0.033	0.000
I_17	45.46	58.61	0.019	0.028	0.000
I_20	45.60	59.34	0.021	0.033	0.000
IK_43	14.21	19.83	0.020	0.025	0.000
IK_44	14.21	19.83	0.010	0.015	0.000
IK_45	16.24	21.43	0.009	0.015	0.000
IK_46	17.10	21.43	0.006	0.011	0.000
IK_62	11.88	18.01	0.020	0.033	0.000
IK_63	14.08	19.61	0.024	0.024	0.000

IK_64	14.08	19.61	0.015	0.030	0.000
UM_205	15.01	15.07	0.015	0.015	0.000
UM_214	13.45	14.47	0.011	0.011	0.000
UM_220	15.43	19.74	0.017	0.027	0.000
UM_231	11.26	16.15	0.017	0.017	0.000
UM_232	10.80	15.73	0.018	0.028	0.000
UM_233	13.39	15.95	0.018	0.018	0.000
UM_234	13.14	15.73	0.021	0.021	0.000
KO_372	13.49	17.95	0.016	0.020	0.000
KO_373	17.59	18.04	0.012	0.017	0.000
KO_452	16.83	21.03	0.008	0.009	0.000
KO_454	17.98	21.03	0.005	0.009	0.000
Specimen1	14.79	22.12	0.042	0.047	0.000
Specimen2	16.48	24.62	0.024	0.049	0.000
U2	61.06	64.46	0.027	0.047	0.000
H-2-1_3	22.21	35.94	0.015	0.024	0.000
H-2-1_5	21.19	29.25	0.014	0.024	0.000
HT-2-1_3	20.89	34.58	0.016	0.025	0.000
HT-2-1_5	20.10	28.16	0.019	0.025	0.000
3CMD12	76.90	79.10	0.011	0.015	0.015
Unit_6	44.04	46.77	0.048	0.048	0.000
SRC	117.92	140.55	0.010	0.021	0.000
A4	39.64	40.26	0.018	0.028	0.000
FS0	41.86	60.10	0.046	0.082	0.082
FS1	41.86	60.10	0.045	0.075	0.075
CUW	54.31	57.96	0.000	0.009	0.000
I18	79.77	84.08	0.000	0.008	0.000
I21	79.57	82.86	0.000	0.015	0.000
C1	36.91	39.11	0.000	0.004	0.004
C4	36.91	59.64	0.000	0.027	0.027
C8	43.05	56.21	0.000	0.005	0.005
C12	41.18	51.44	0.000	0.066	0.066
D1	87.14	96.15	0.000	0.029	0.029
D13	65.43	73.06	0.000	0.021	0.021
D14	65.43	73.06	0.000	0.082	0.082
D16	85.23	94.87	0.000	0.022	0.022
WI_0_033E	15.97	16.49	0.000	0.029	0.000

Table A-3-9: Additional calculated data of condition iii rectangular columns

Column designation	V_P (kips)	V_o (kips)	a	b_P	b_R
WI_40_033aE	20.68	20.65	0.028	0.025	0.000
WI_40_033aW	20.68	20.65	0.028	0.028	0.000
WI_40_033_E	20.36	20.34	0.036	0.037	0.000
WI_40_033_W	20.36	20.34	0.026	0.041	0.000
UM_207	22.52	18.89	0.009	0.013	0.000
BR-S1	132.96	127.49	0.006	0.015	0.000
UnitR1A	116.53	106.08	0.010	0.010	0.000
3CMH18	76.90	61.98	0.006	0.016	0.016
3SLH18	67.02	47.04	0.006	0.026	0.026
Unit_7	44.04	42.55	0.015	0.015	0.000
RRC	108.67	104.35	0.008	0.009	0.000
C1	25.64	23.30	0.008	0.013	0.000
UNIT_1	111.03	108.95	0.000	0.000	0.000
OA2	33.62	23.91	0.000	0.003	0.000
OA5	35.80	32.81	0.000	0.002	0.000
CUS	111.14	91.18	0.000	0.020	0.000
UNIT_1_1	70.64	50.05	0.000	0.000	0.000
SC3	111.07	69.56	0.000	0.005	0.000
SC9	194.19	171.97	0.000	0.012	0.000
UnitR3A	93.93	64.94	0.000	0.005	0.000
UnitR5A	92.84	63.70	0.000	0.008	0.000
Specimen_B1	32.85	22.62	0.000	0.005	0.000
Specimen_CE	29.90	22.44	0.000	0.001	0.000
Specimen_BE	29.88	25.09	0.000	0.002	0.000
Specimen_LE	63.53	53.57	0.000	0.006	0.000
No.1	53.56	46.77	0.000	0.124	0.124
No.3	53.56	40.43	0.000	0.012	0.012
No.4	56.67	52.22	0.000	0.012	0.012
D11	67.25	54.52	0.000	0.011	0.011
D12	67.25	54.52	0.000	0.009	0.009
N-18M	64.72	53.57	0.000	0.093	0.093
N-27C	67.65	59.58	0.000	0.023	0.023
N-27M	67.65	59.58	0.000	0.035	0.035
S-1	115.76	69.75	0.000	0.066	0.066
3CLH18	67.02	47.04	0.000	0.010	0.010
A1	38.70	29.01	0.000	0.011	0.000

Table A-3-10: Additional calculated data of condition i circular columns

Column designation	V_P (kips)	V_o (kips)	a	b_P	b_R
No.1	28.82	120.05	0.032	0.046	0.000
No. 2	7.24	29.79	0.030	0.054	0.000
No.3	15.16	39.07	0.036	0.036	0.000
No.2	30.21	90.03	0.011	0.025	0.000
No.5A	169.46	352.77	0.019	0.020	0.000
No.5B	115.89	398.24	0.011	0.012	0.000
No.5	33.15	59.45	0.036	0.052	0.000
No.6	29.45	102.01	0.021	0.034	0.000
No.10	39.83	71.53	0.014	0.015	0.000
No.11	28.84	112.03	0.009	0.017	0.000
M1E1	7.10	16.77	0.020	0.030	0.000
M1E2	8.29	17.50	0.019	0.023	0.000
Con1	4.59	18.56	0.040	0.057	0.000
Con2	9.18	20.56	0.059	0.059	0.000
Con3	9.01	21.18	0.059	0.061	0.000
NIST, Full scale Flexure	313.15	775.89	0.046	0.053	0.000
NIST Full scale shear	623.01	1605.28	0.067	0.067	0.000
NIST Model N1	14.74	41.39	0.071	0.102	0.000
NIST Model N2	15.94	43.07	0.064	0.090	0.000
NIST Model N3	7.49	21.65	0.056	0.063	0.000
NIST Model N4	14.79	41.43	0.067	0.081	0.000
NIST Model N5	16.23	43.23	0.059	0.077	0.000
NIST Model N6	7.33	20.23	0.039	0.069	0.000
BRI No.2	17.18	58.65	0.019	0.032	0.000
BRI No.3 ws27bs	25.89	62.62	0.051	0.077	0.000
A2	15.76	40.39	0.044	0.044	0.000
A3	15.76	40.39	0.103	0.103	0.000
A4	16.82	41.35	0.029	0.031	0.000
A5	16.82	41.35	0.040	0.040	0.000
A6	16.82	41.35	0.057	0.058	0.000
A7	16.50	41.06	0.032	0.048	0.000
A8	16.50	41.06	0.047	0.047	0.000
A9	16.46	41.03	0.046	0.056	0.000
A10	15.48	40.16	0.055	0.055	0.000
A11	15.48	40.16	0.049	0.065	0.000
A12	15.48	40.16	0.065	0.065	0.000
SRPH1	68.90	151.09	0.073	0.073	0.000

NH6	162.40	303.86	0.076	0.077	0.000
FL1	34.02	87.27	0.073	0.073	0.000
FL2	35.75	64.89	0.037	0.039	0.000
415	59.42	173.71	0.054	0.065	0.000
815	29.71	154.14	0.072	0.072	0.000
1015	23.77	150.22	0.088	0.087	0.000
407	39.92	173.71	0.043	0.046	0.000
430	94.78	173.71	0.059	0.061	0.000
328	119.78	227.36	0.063	0.064	0.000
828	44.92	190.56	0.138	0.138	0.000
1028	35.93	186.14	0.123	0.124	0.000
IC3	81.02	151.14	0.072	0.073	0.000
RC1	15.64	90.06	0.082	0.082	0.000
RC2	15.37	86.36	0.065	0.065	0.000
RC3	18.61	94.63	0.050	0.050	0.000
RC4	18.58	67.61	0.023	0.034	0.000
RC6	18.50	31.88	0.025	0.034	0.000
RC7	17.84	90.76	0.075	0.075	0.000
RC8	18.61	94.63	0.036	0.035	0.000
RC9	18.49	90.93	0.057	0.057	0.000
415p	71.85	184.74	0.061	0.061	0.000
C1	26.09	103.35	0.084	0.086	0.000
C2	26.28	103.62	0.101	0.100	0.000
C3	26.92	113.92	0.091	0.091	0.000
C4	41.18	125.33	0.080	0.080	0.000
C5	43.15	125.33	0.024	0.104	0.000
C6	43.52	125.33	0.022	0.087	0.000
C7	43.52	125.33	0.022	0.082	0.000
C8	43.15	125.33	0.023	0.088	0.000
1	33.84	81.86	0.060	0.062	0.000
2	34.25	82.15	0.087	0.090	0.000
3	33.56	81.66	0.084	0.086	0.000
4	34.17	82.09	0.114	0.063	0.000
UC1	15.14	62.85	0.051	0.051	0.000
UC2	15.14	62.85	0.058	0.078	0.000
UC3	15.11	62.70	0.094	0.114	0.000
Unit No.3 (Potangaroa)	133.32	239.14	0.010	0.010	0.000
M2E1	14.85	34.76	0.030	0.030	0.000
M2E2	17.45	36.55	0.035	0.035	0.000
ws21bs	35.34	90.85	0.026	0.078	0.000
ws25bs	37.41	68.01	0.028	0.068	0.000

Table A-3-11: Additional calculated data of condition ii circular columns

Column designation	V_P (kips)	V_o (kips)	a	b_P	b_R
No. 1	50.99	54.87	0.038	0.049	0.000
No. 2	51.29	55.37	0.004	0.041	0.000
No.3	51.17	57.81	0.047	0.048	0.000
No.1	31.16	49.30	0.032	0.032	0.000
No.1	149.41	169.63	0.030	0.031	0.000
No.4	170.93	240.97	0.023	0.023	0.000
No.9	70.65	85.64	0.048	0.048	0.000
No.1	94.08	107.30	0.042	0.041	0.041
No.3	98.15	122.23	0.025	0.032	0.000
BRI No.3 ws22bs	19.47	32.36	0.044	0.045	0.000
No.16	42.16	44.99	0.027	0.027	0.000
No.20	47.00	51.99	0.027	0.028	0.000
NH1	116.36	163.68	0.042	0.042	0.000
NH3	104.96	146.53	0.046	0.046	0.000
FL3	35.15	50.34	0.075	0.075	0.000
IC1	81.88	114.42	0.062	0.062	0.000
B105IC2	83.48	116.34	0.055	0.055	0.000
Col 1	71.91	74.94	0.028	0.028	0.028
Col 2	67.41	72.00	0.029	0.052	0.052
Col 3	64.97	70.70	0.032	0.032	0.032
Col 4	64.14	69.14	0.023	0.024	0.024
415s	61.33	109.43	0.041	0.062	0.000
Test3	54.25	54.82	0.030	0.030	0.000
1	19.03	29.29	0.030	0.030	0.000
Unit No.8	86.79	93.25	0.036	0.036	0.000
Unit No.10	87.82	90.30	0.028	0.031	0.000
Unit No.15	48.49	48.66	0.042	0.040	0.000
ws26bs	20.57	25.79	0.039	0.040	0.000
Unit No.23	55.06	66.17	0.021	0.032	0.000
NR 1	80.45	131.16	0.030	0.023	0.000
NH2	96.87	138.83	0.013	0.015	0.000
NH4	159.38	258.97	0.075	0.078	0.000
NH5	99.08	114.93	0.064	0.064	0.000
UC15	26.88	46.77	0.033	0.033	0.000
Specimen S1	50.49	55.35	0.033	0.041	0.041
Specimen S3	64.75	69.40	0.029	0.041	0.041
Specimen C2	65.28	69.91	0.032	0.032	0.032
Specimen C3R	62.31	67.04	0.024	0.023	0.023
Specimen S3	12.11	13.89	0.000	0.008	0.000

Table A-3-12: Additional calculated data of condition iii circular columns

Column designation	V_P (kips)	V_o (kips)	a	b_P	b_R
No.21	35.65	30.60	0.029	0.029	0.000
No.26	38.80	34.82	0.030	0.030	0.000
Unit No.1	75.48	49.81	0.020	0.018	0.000
Unit No.2	55.07	49.70	0.031	0.031	0.000
Unit No.3	59.96	43.85	0.004	0.004	0.000
Unit No.5	73.15	58.46	0.013	0.014	0.000
Unit No.11	88.32	69.22	0.003	0.013	0.000
Unit No.12	108.79	97.13	0.008	0.031	0.000
Unit No.13	87.14	84.46	0.030	0.052	0.000
Unit No.14	74.42	48.24	0.033	0.033	0.000
Unit No.17	68.39	53.22	0.016	0.034	0.000
Unit No.23	71.87	59.35	0.027	0.027	0.000
Unit No.24	72.75	57.75	0.030	0.049	0.000
Unit No.2 (Wong)	99.73	87.28	0.013	0.023	0.000
Unit No.10	55.83	53.26	0.022	0.028	0.000
Unit No.15	42.25	28.92	0.020	0.027	0.000
NR2	120.39	117.78	0.012	0.016	0.000
UC13	30.83	30.62	0.006	0.011	0.000
UC14	30.83	30.62	0.005	0.006	0.000
CCS1	134.83	98.09	0.007	0.008	0.000
I 30	92.45	78.42	0.012	0.021	0.000
UNIT 4	71.79	46.55	0.000	0.000	0.000
UNIT 6	97.03	55.17	0.000	0.009	0.000
UNIT 7	74.04	43.37	0.000	0.000	0.000
UNIT 16	84.71	60.35	0.000	0.023	0.000
UNIT 18	86.11	61.51	0.000	0.015	0.000
UNIT 19	114.11	68.53	0.000	0.027	0.000
UNIT 20	112.13	71.71	0.000	0.025	0.000
UNIT 21	73.95	42.52	0.000	0.011	0.000
UNIT 22	71.91	40.95	0.000	0.026	0.000
UNIT 1	62.77	31.23	0.000	0.013	0.000
UNIT 2	62.95	41.70	0.000	0.007	0.000
UNIT 4	71.15	42.82	0.000	0.011	0.000
UNIT 6	70.34	52.63	0.000	0.014	0.000
UNIT 8	72.21	62.54	0.000	0.010	0.000
UNIT 9	86.90	53.38	0.000	0.013	0.000
UNIT 12	74.27	50.17	0.000	0.016	0.000
UNIT 13	77.42	61.65	0.000	0.017	0.000

UNIT 14	78.32	70.81	0.000	0.014	0.000
UNIT 17	71.84	47.31	0.000	0.007	0.000
UNIT 19	47.85	36.25	0.000	0.011	0.000
UNIT 22	42.67	33.21	0.000	0.013	0.000
UNIT 24	77.84	55.53	0.000	0.010	0.000
UNIT 25	50.83	41.35	0.000	0.011	0.000
UNIT 27	41.47	37.77	0.000	0.013	0.000
UNIT 28	56.69	44.40	0.000	0.017	0.000
UNIT S-1	87.48	65.91	0.000	0.000	0.000
UNIT S1-2	86.32	62.96	0.000	0.001	0.000
UNIT S2	85.34	67.23	0.000	0.003	0.000
Unit CS-A1	110.59	95.01	0.000	0.001	0.000
Unit CS-A	147.82	124.92	0.000	0.006	0.000
Specimen BR-C1	142.17	121.72	0.000	0.007	0.000
Specimen S1	17.99	14.63	0.000	0.000	0.000
Specimen CR-C	100.05	89.43	0.000	0.007	0.000

APPENDIX B FORCE DISPLACEMENT PLOTS OF DATABASE COLUMNS

Force-Displacement (FD) relations of all the columns in database are presented in this section. The plots are arranged based on the initial categorization into different failure modes.

The different categories of columns are identified by the following abbreviation

FC-R = **F**lexure **C**ritical **R**ectangular columns

FSC-R = **F**lexure-**S**hear **C**ritical **R**ectangular columns

SC-R = **S**hear **C**ritical **R**ectangular columns

FC-C = **F**lexure **C**ritical **C**ircular columns

FSC-C = **F**lexure-**S**hear **C**ritical **C**ircular columns

SC-C = **S**hear **C**ritical **C**ircular columns

Different behavioral milestones are plotted on the FD hysteresis loops and are identified on the plots by the following markers.

□ - V_y , δ_y (0.7 V_{max})

◇ - V_y , δ_y (0.6 V_{max})

▽ - V_{max} , δ_{vmax}

○ - $\delta_{0.8}$

* - V_s , δ_s

Δ - δ_{bP}

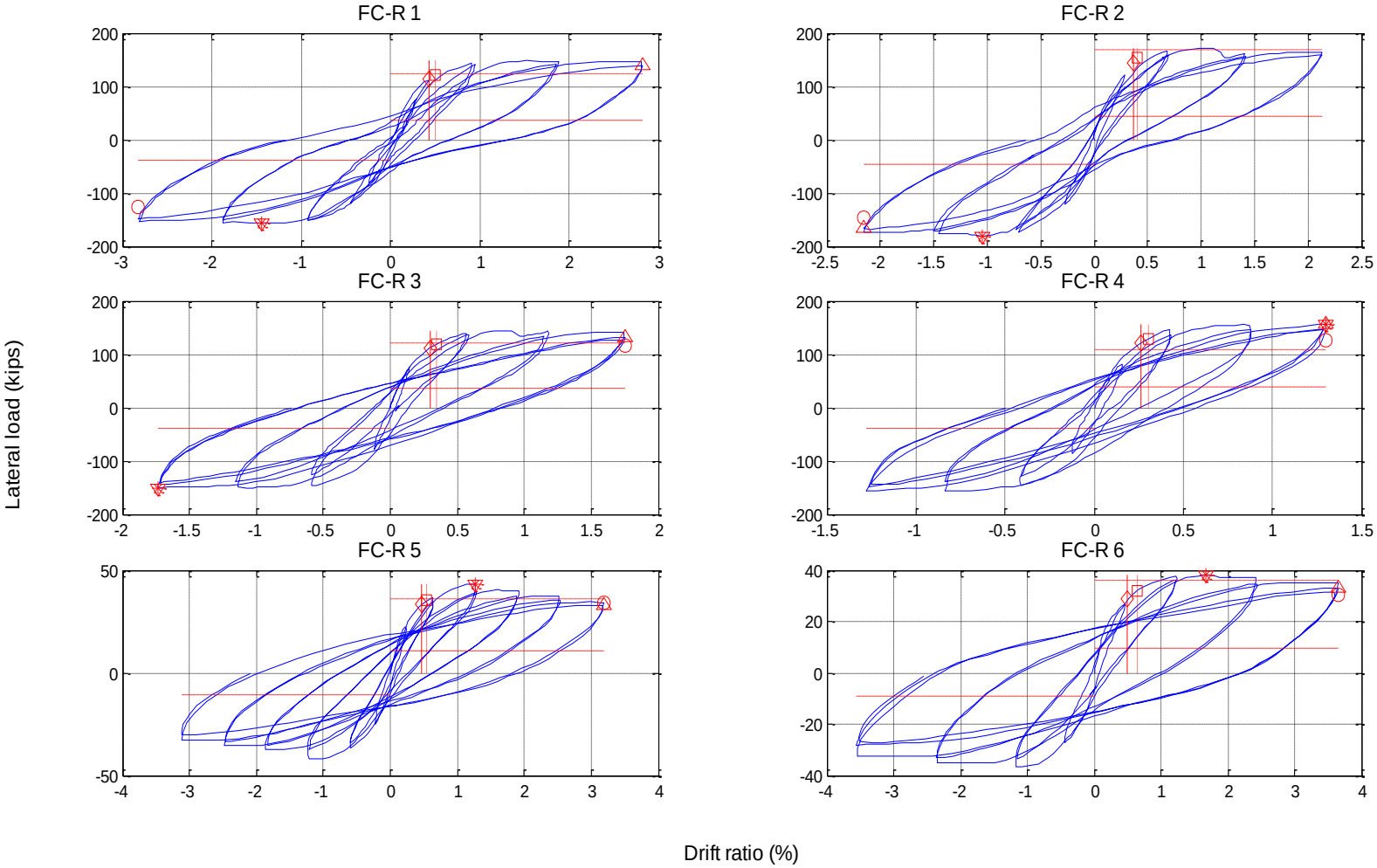
——— Vertical line at δ_y (0.6 V_{max})

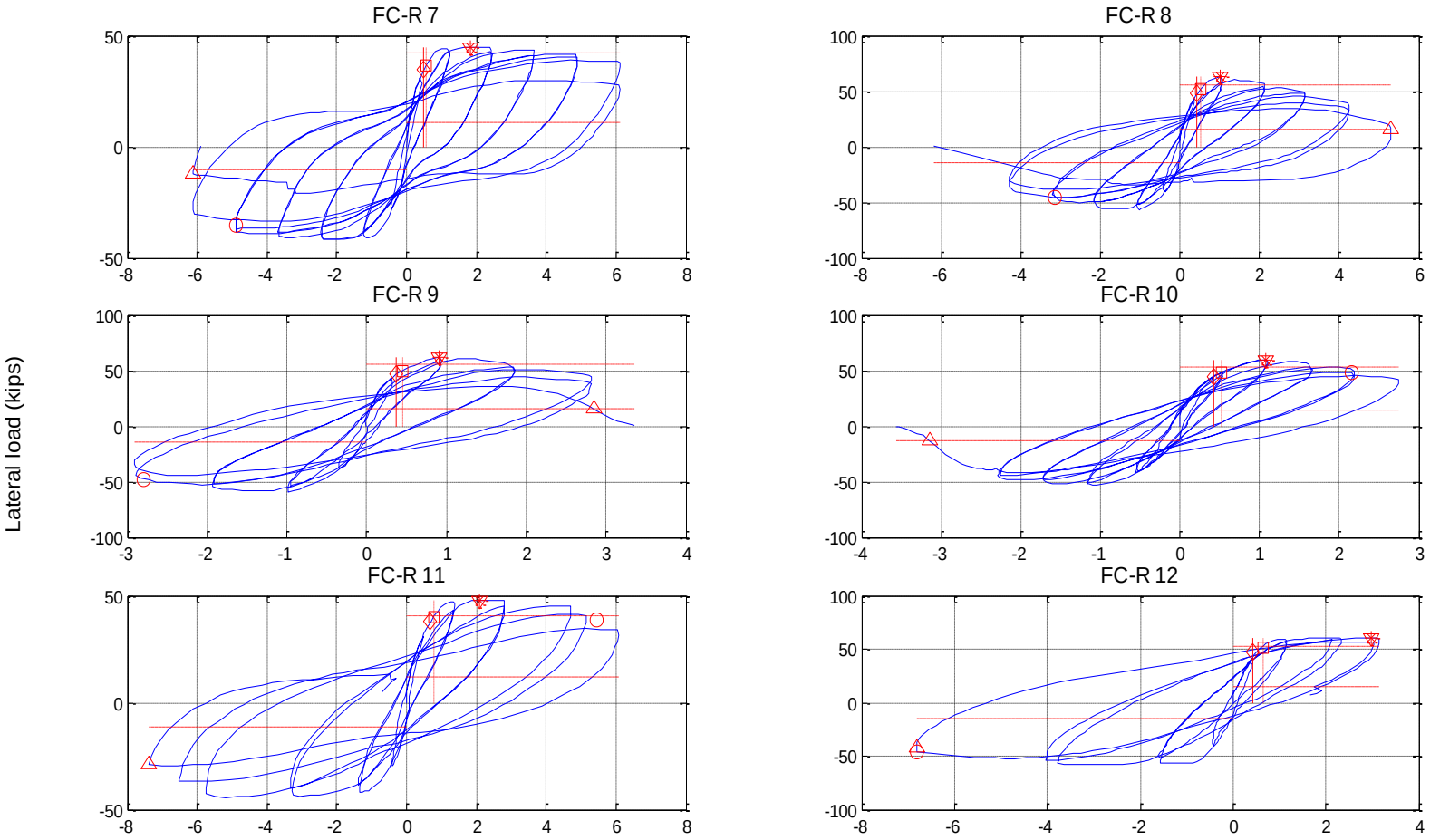
- - - - - - - - - - Vertical line at δ_y (0.7 V_{max})

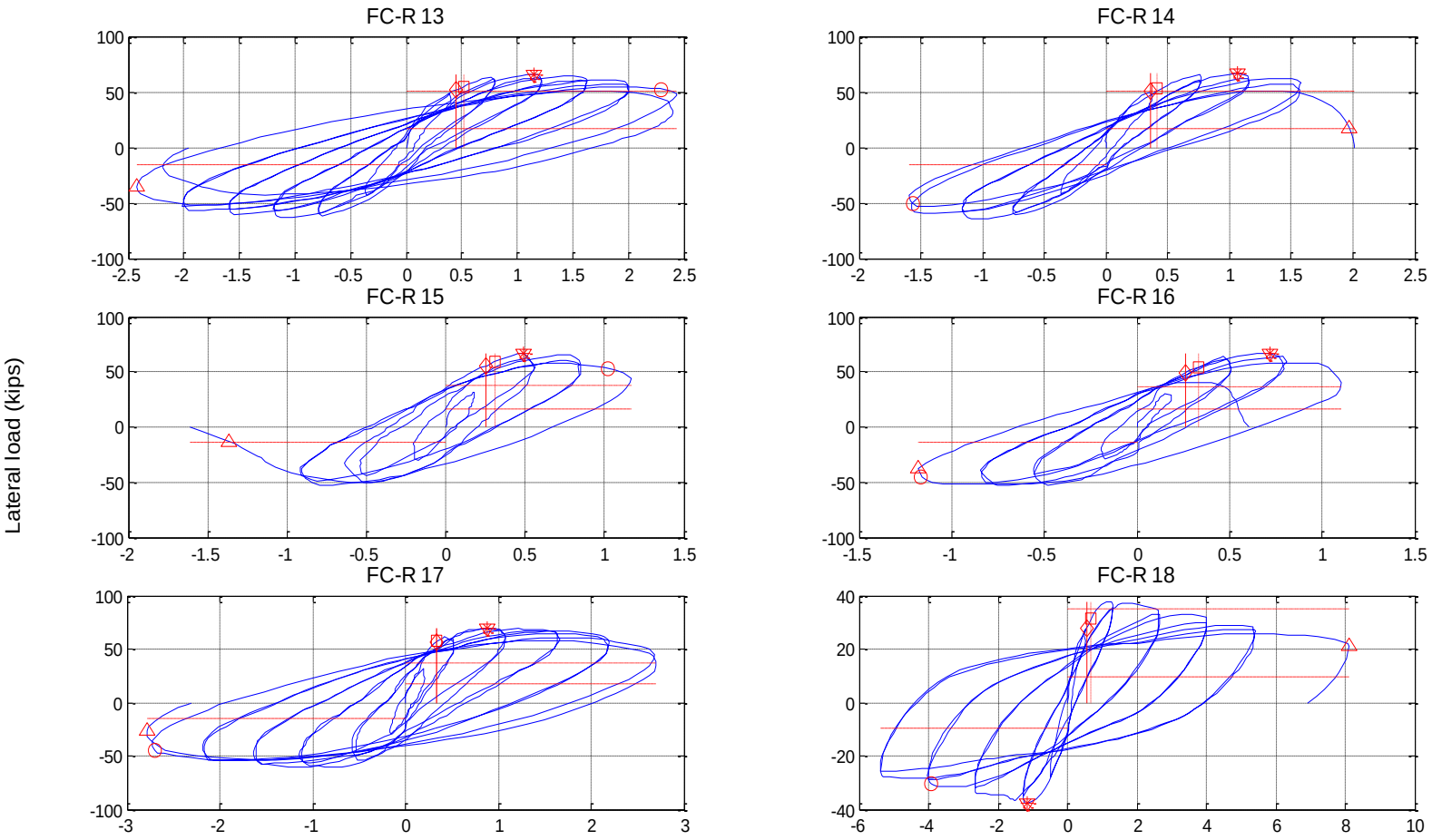
— — — — Horizontal line at 0.25 V_{max} (in both +ve and –ve loading directions)

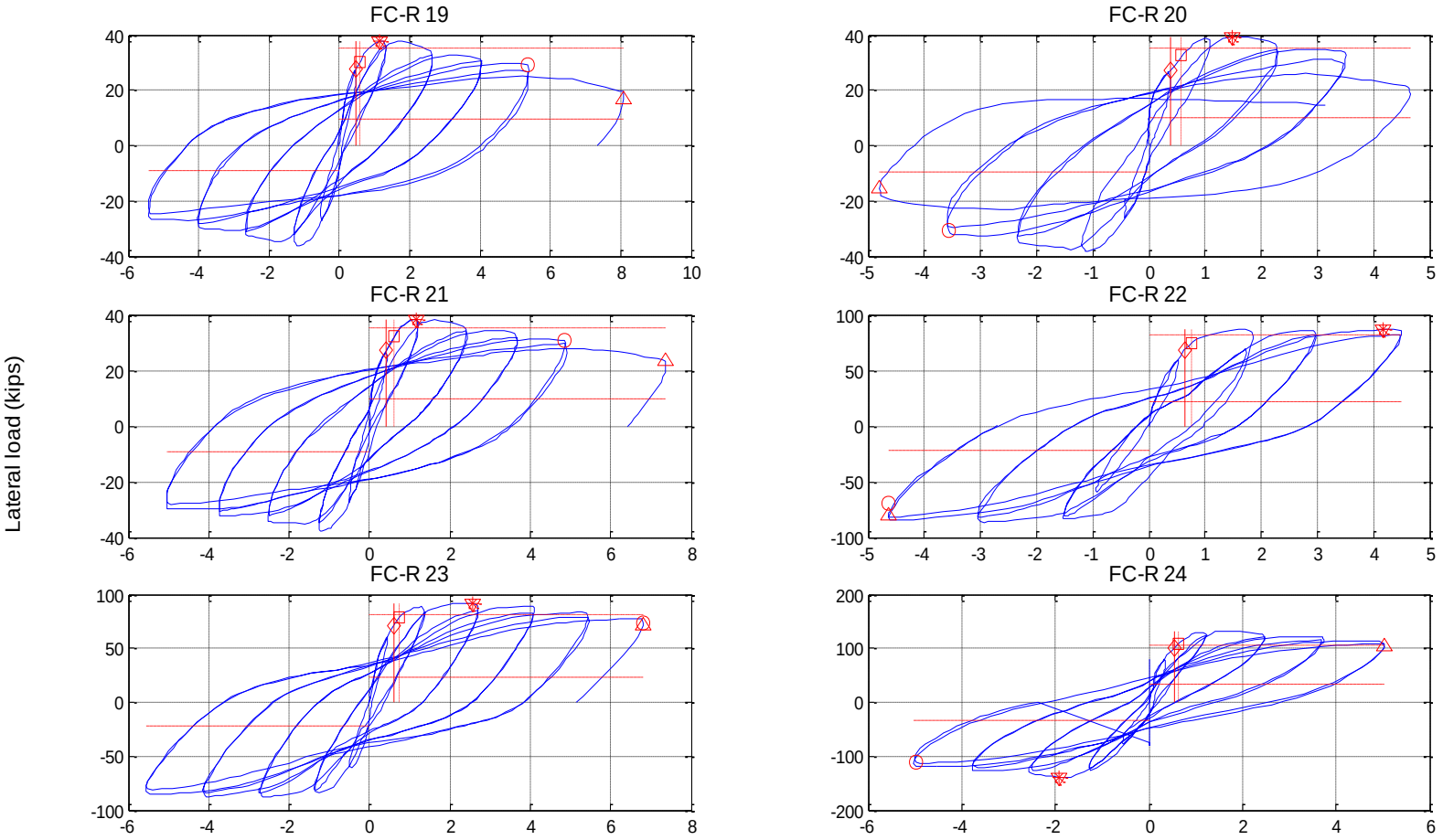
— · — · — Horizontal line at V_P

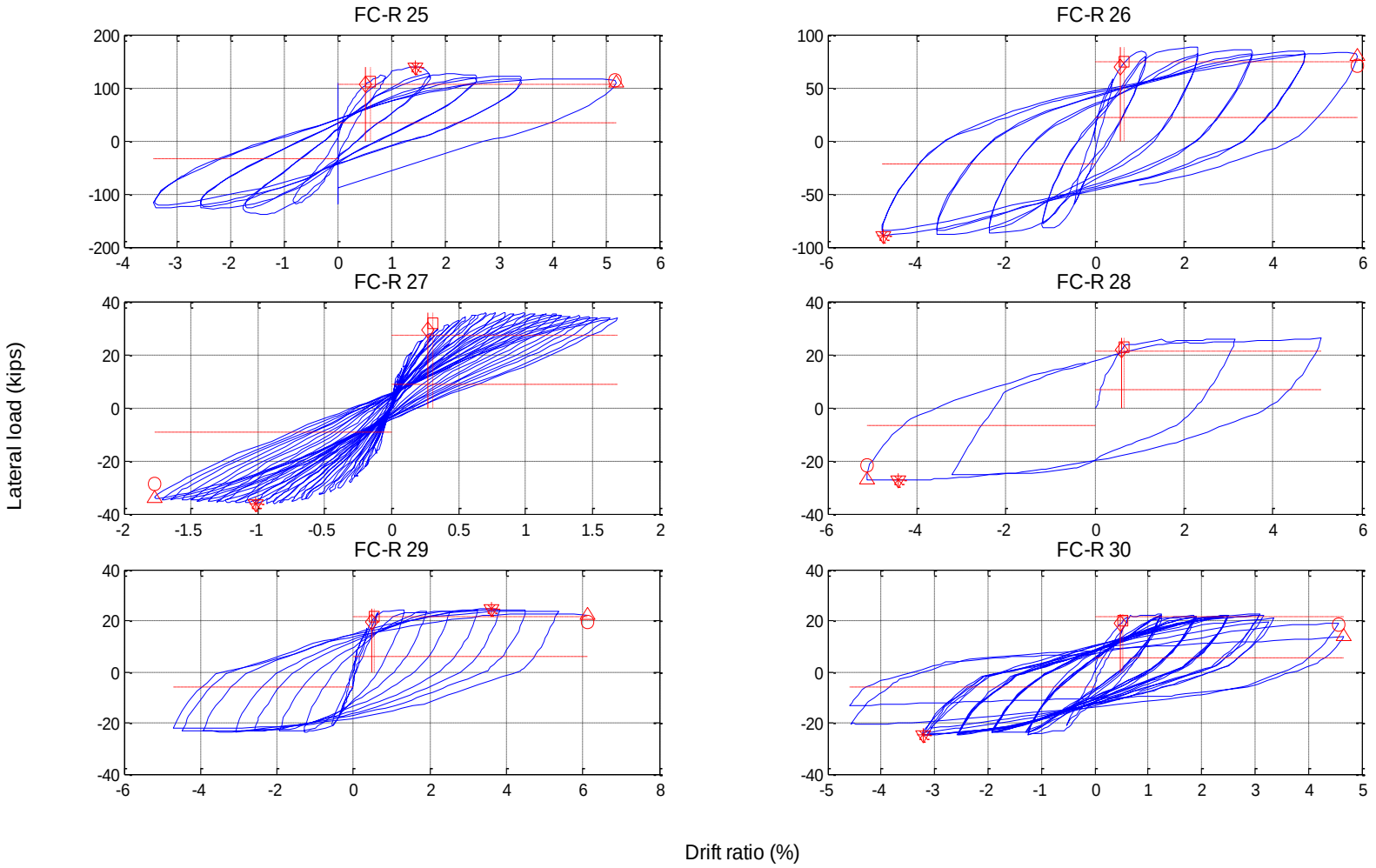
Figure B.1: FD plots of FC-R columns

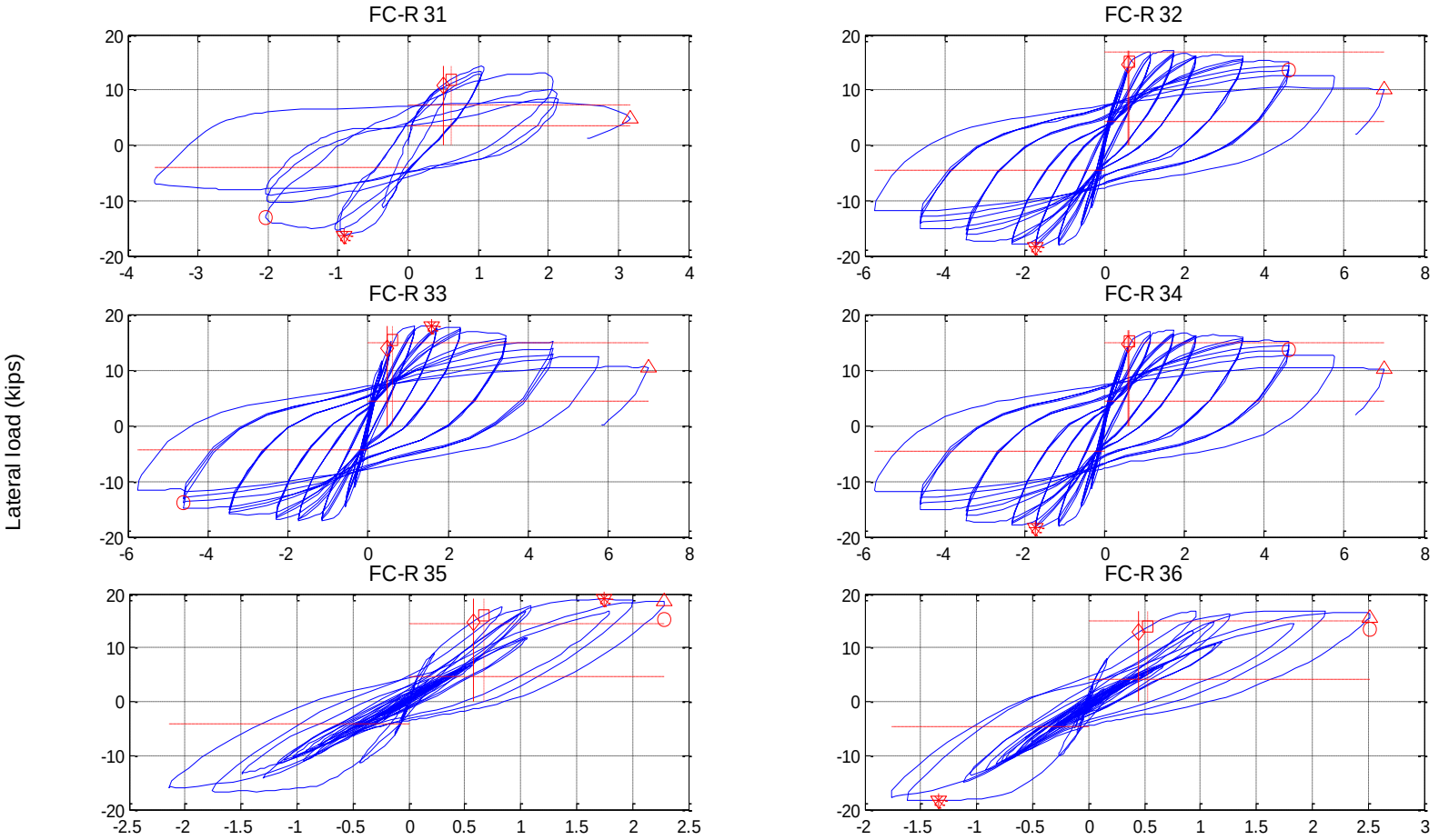


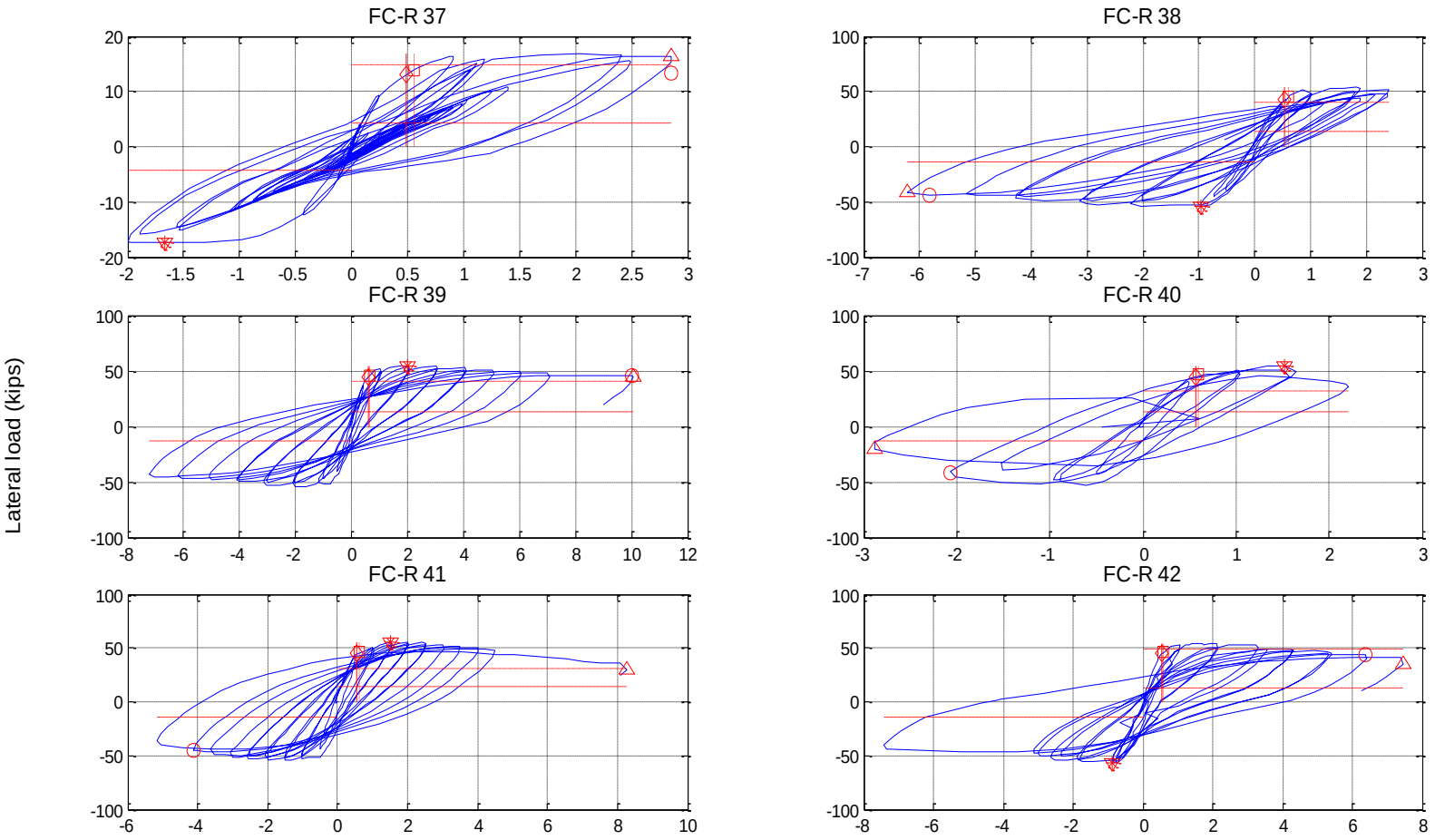

FC-R 7
FC-R 8
FC-R 9
FC-R 10
FC-R 11
FC-R 12
Lateral load (kips)
Drift ratio (%)

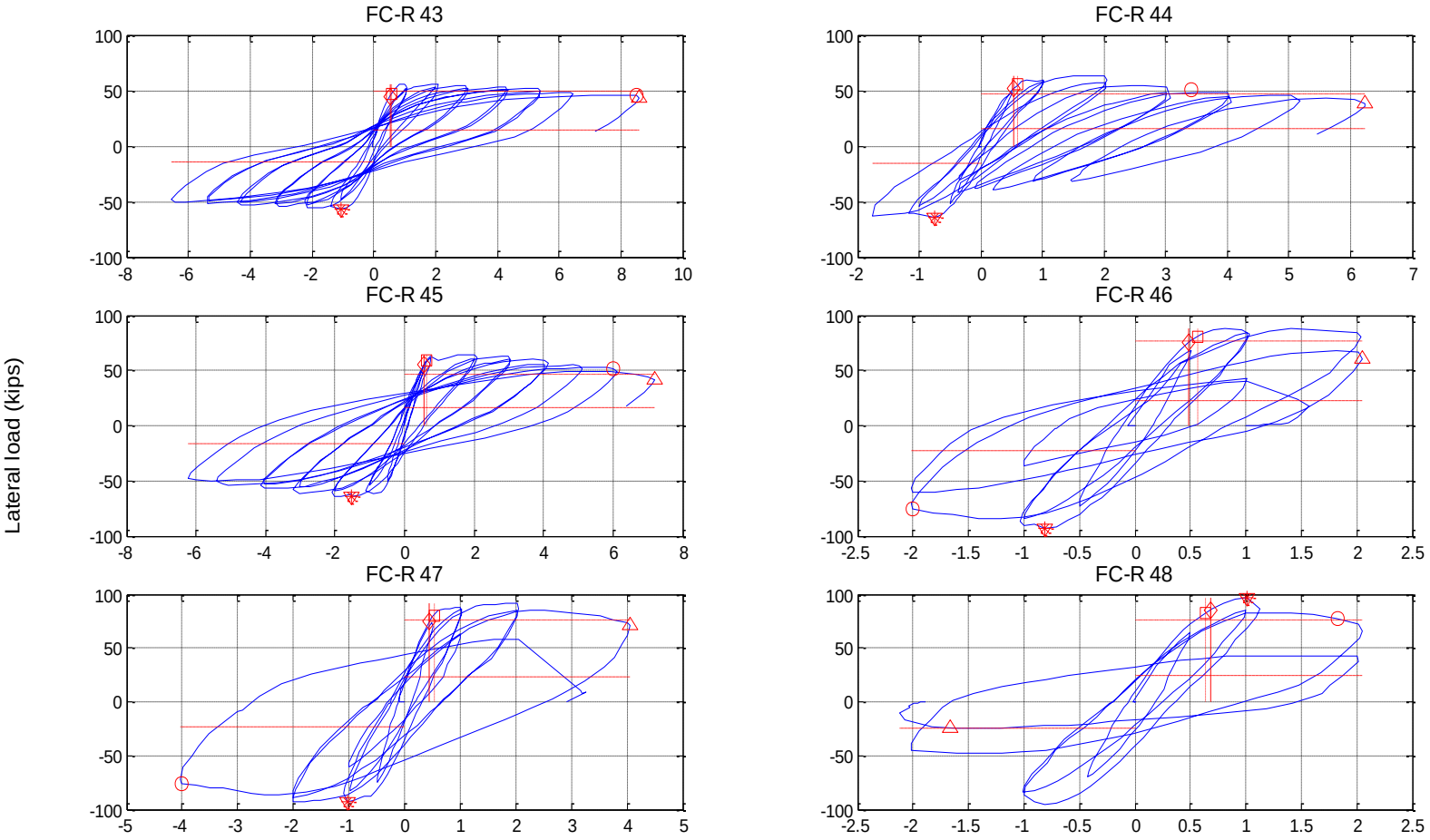

FC-R 13
FC-R 14
FC-R 15
FC-R 16
FC-R 17
FC-R 18
Lateral load (kips)
Drift ratio (%)

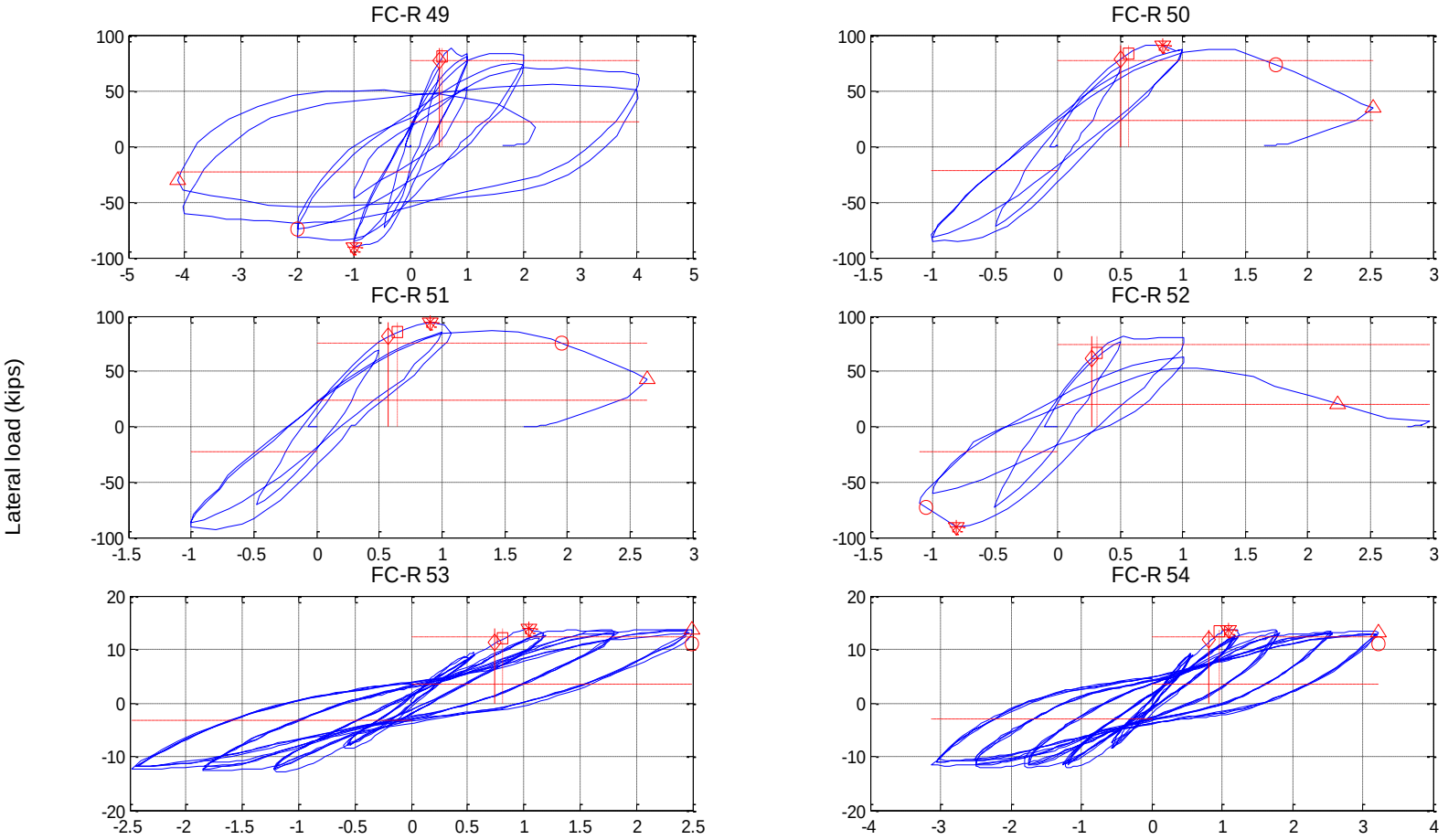

FC-R 19
FC-R 20
FC-R 21
FC-R 22
FC-R 23
FC-R 24
Lateral load (kips)
Drift ratio (%)

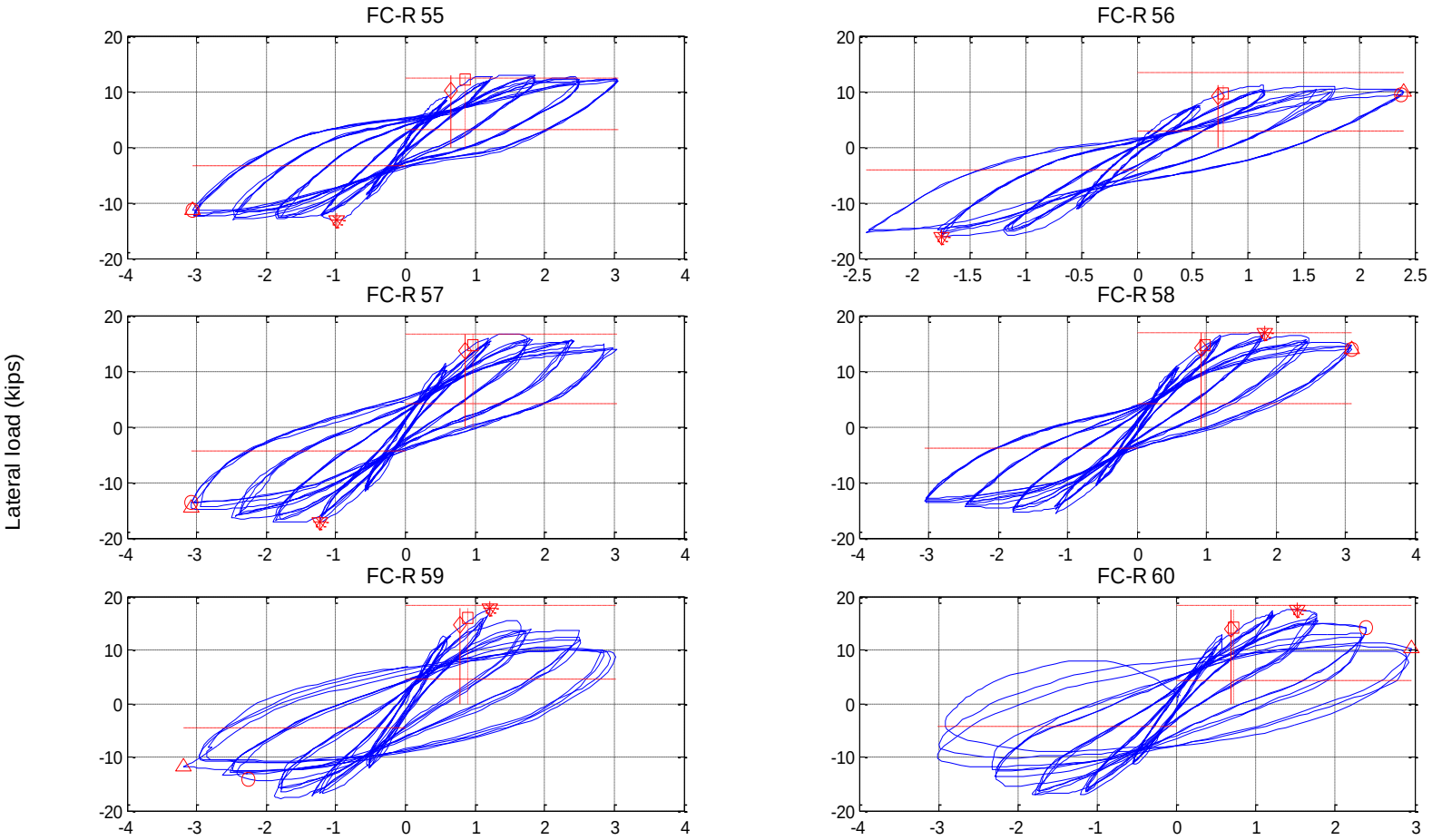

FC-R 25
FC-R 26
FC-R 27
FC-R 28
FC-R 29
FC-R 30
Lateral load (kips)
Drift ratio (%)

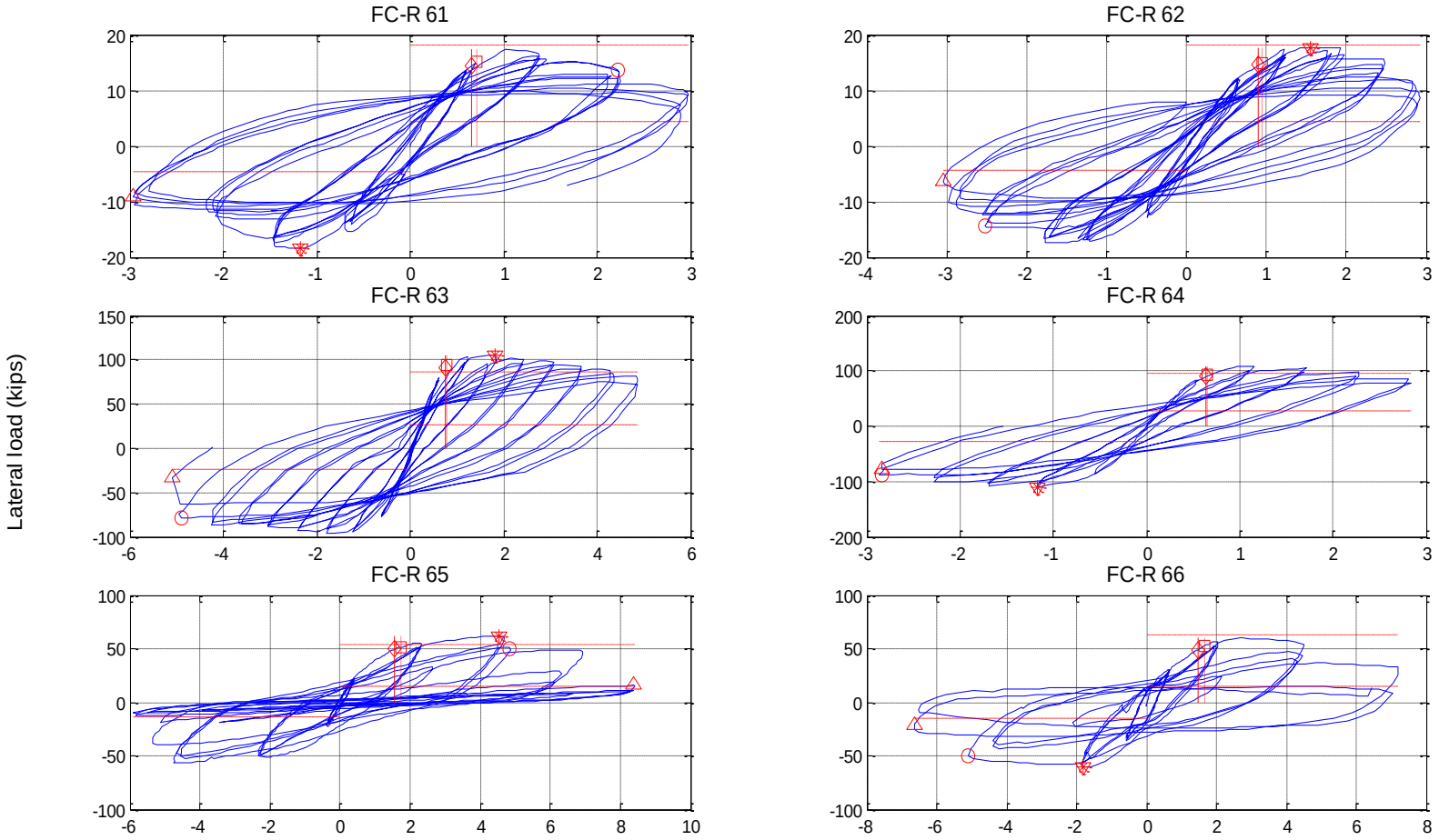

FC-R 31
FC-R 32
FC-R 33
FC-R 34
FC-R 35
FC-R 36
Lateral load (kips)
Drift ratio (%)

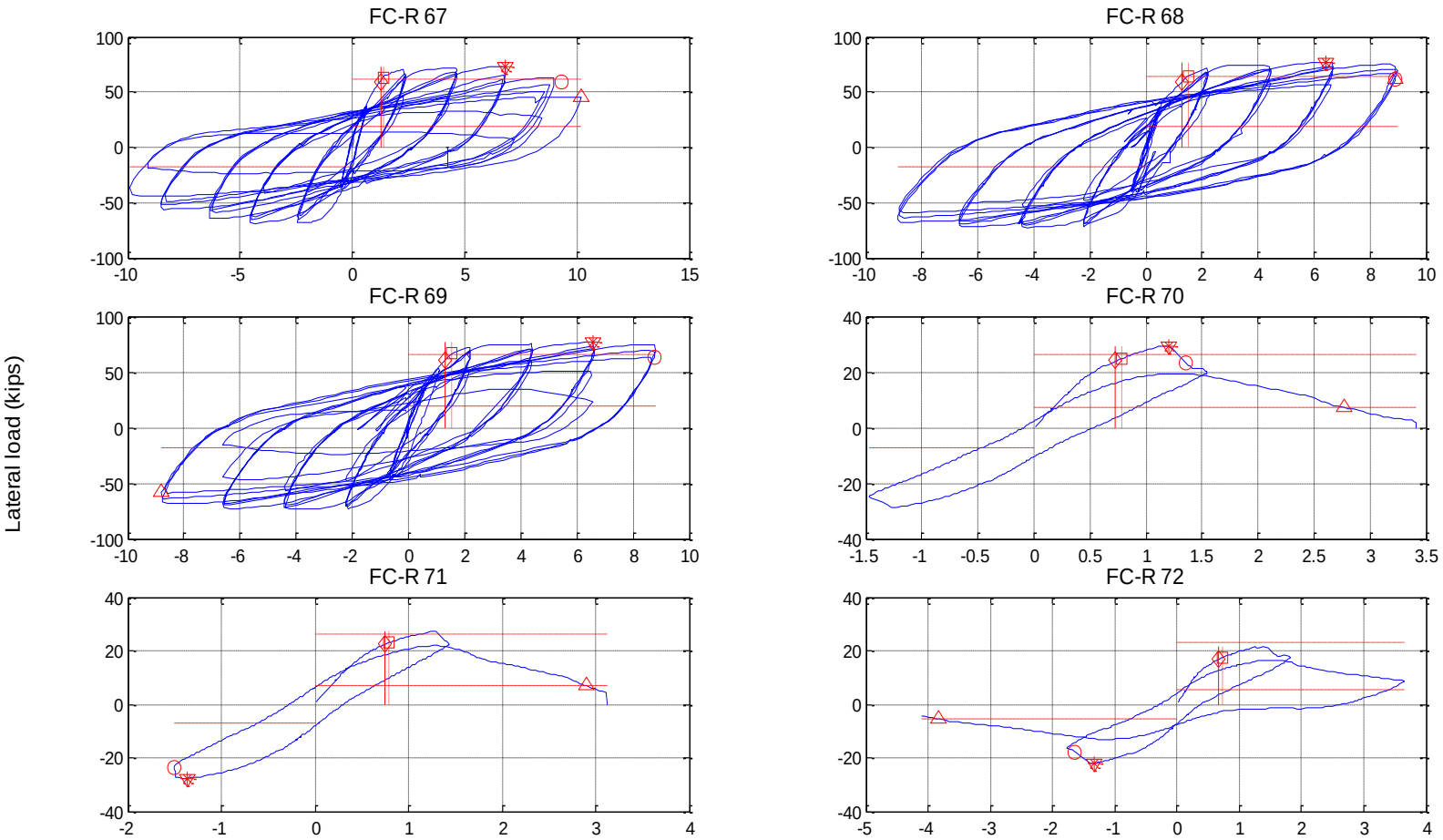

FC-R 37
FC-R 38
FC-R 39
FC-R 40
FC-R 41
FC-R 42
Lateral load (kips)
Drift ratio (%)

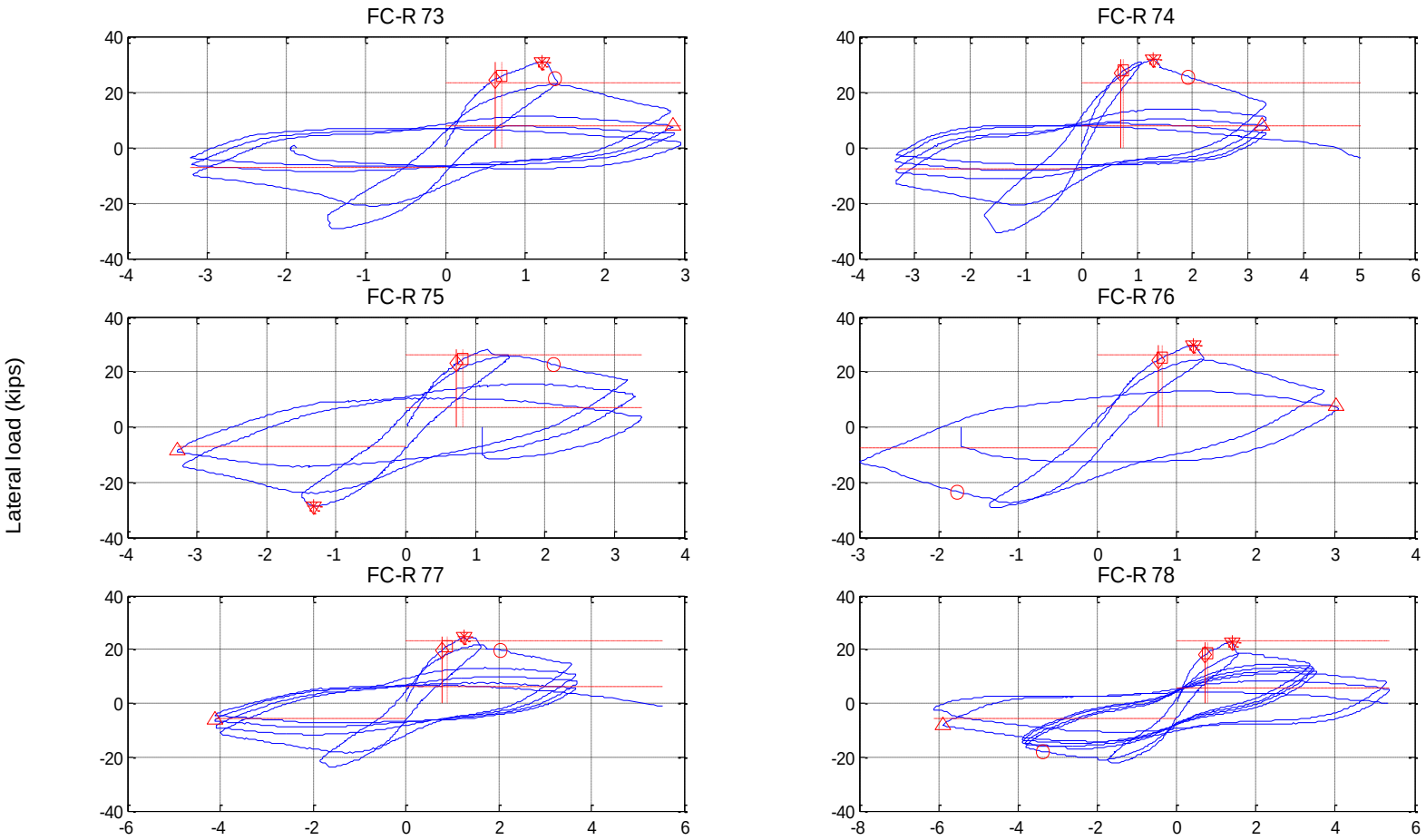

FC-R 43
FC-R 44
FC-R 45
FC-R 46
FC-R 47
FC-R 48
Lateral load (kips)
Drift ratio (%)

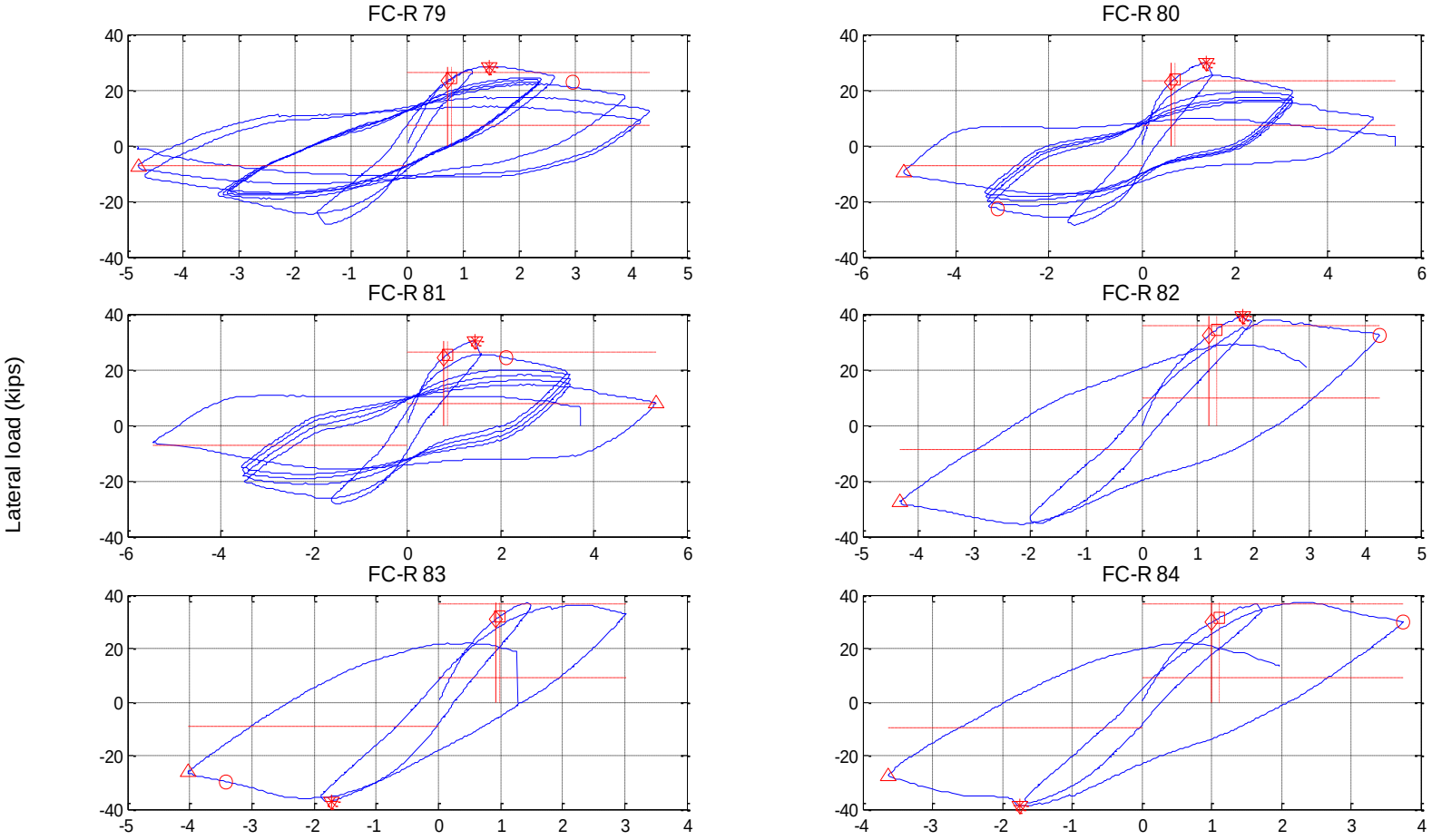

FC-R 49
FC-R 50
FC-R 51
FC-R 52
FC-R 53
FC-R 54
Lateral load (kips)
Drift ratio (%)

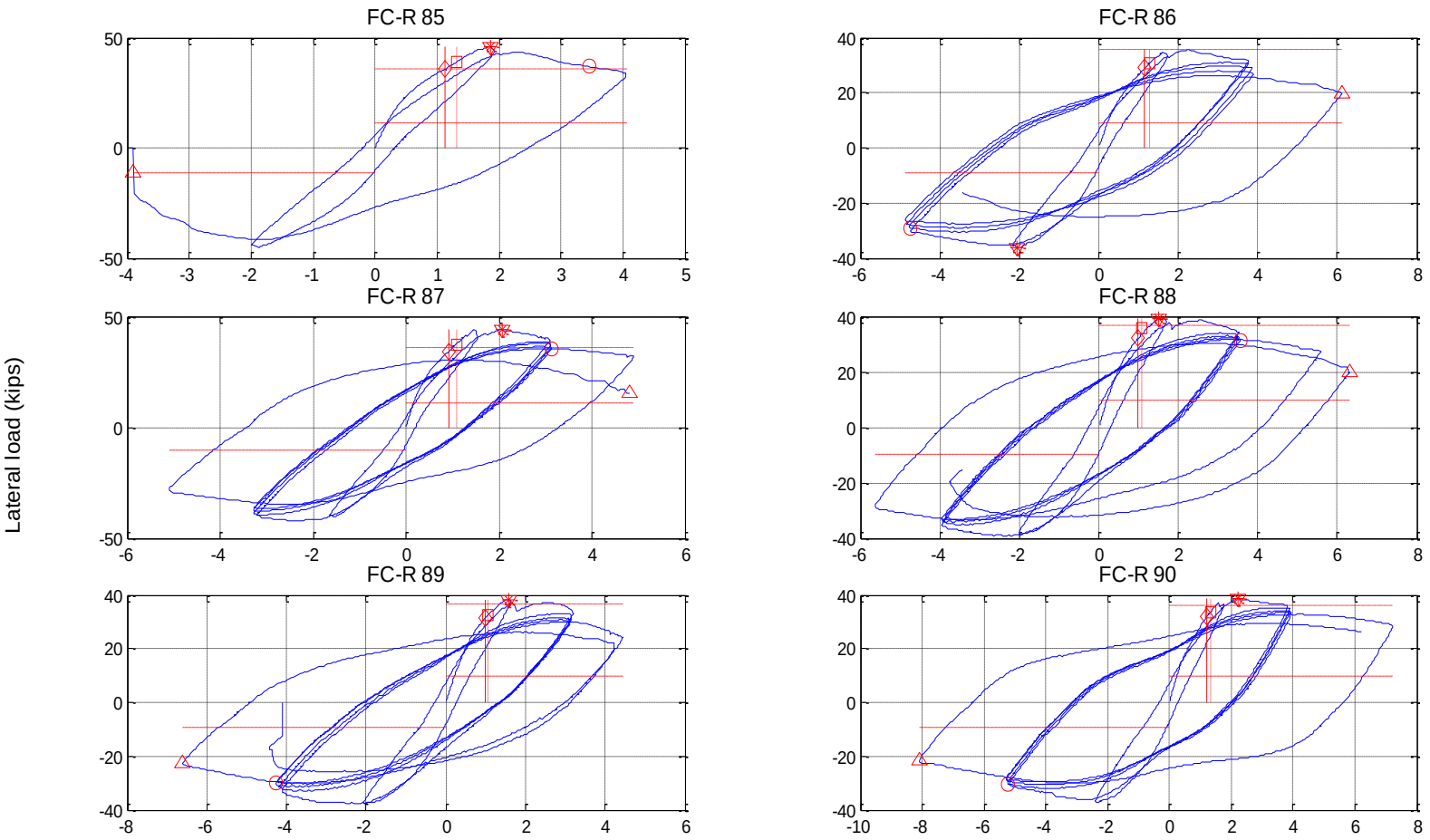

FC-R 55
FC-R 56
FC-R 57
FC-R 58
FC-R 59
FC-R 60
Lateral load (kips)
Drift ratio (%)

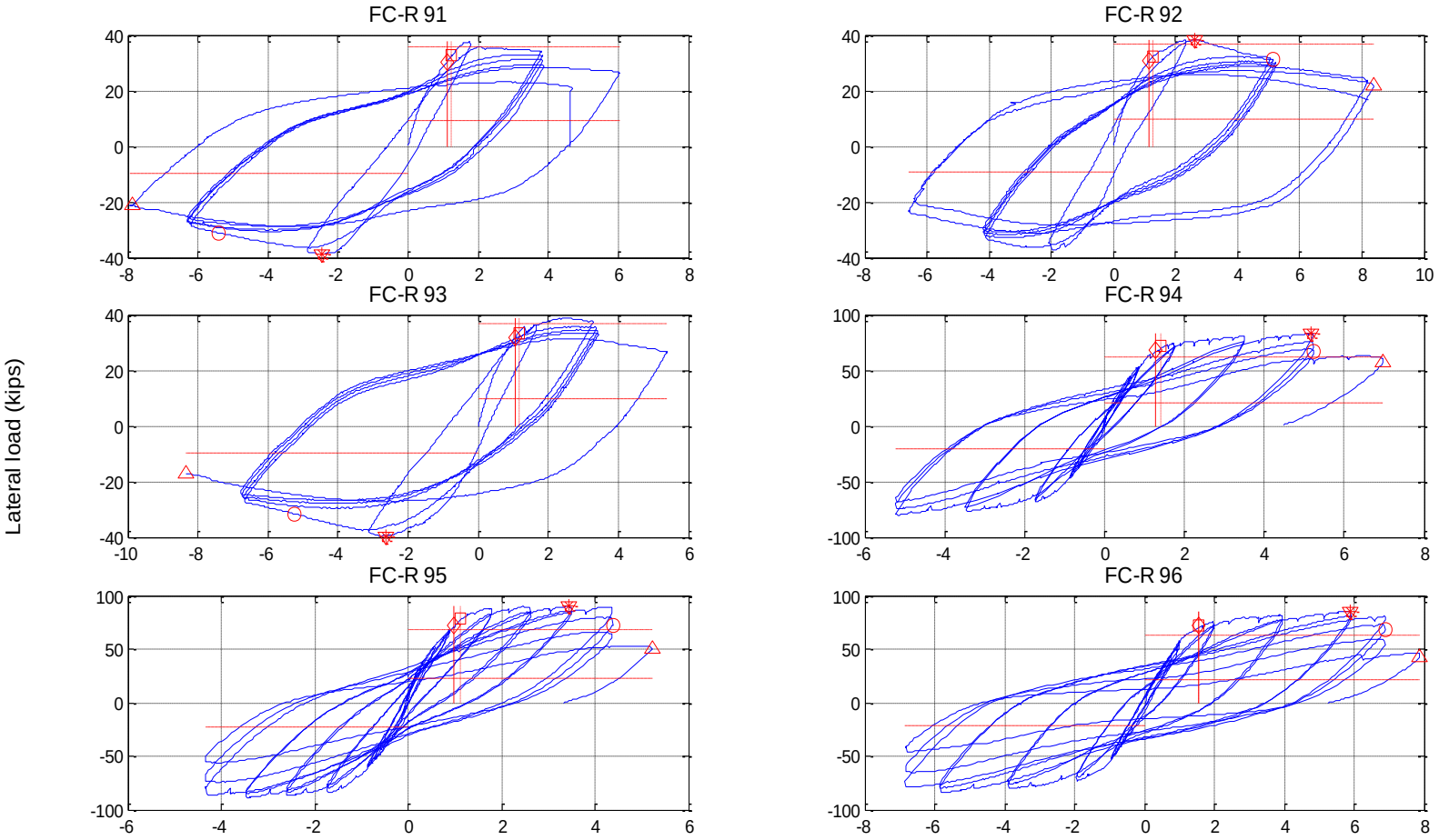

FC-R 61
FC-R 62
FC-R 63
FC-R 64
FC-R 65
FC-R 66
Lateral load (kips)
Drift ratio (%)

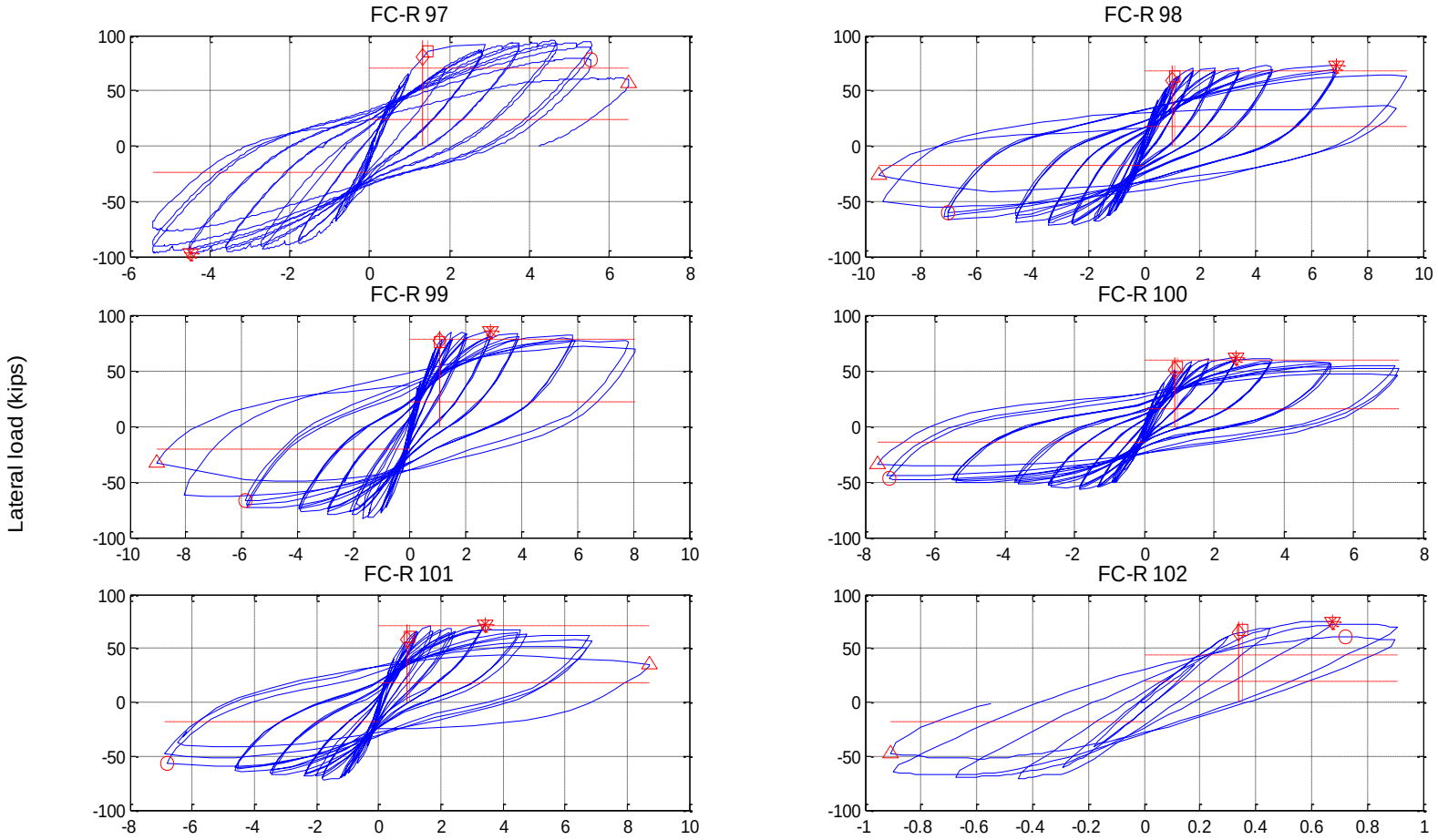

FC-R 67
FC-R 68
FC-R 69
FC-R 70
FC-R 71
FC-R 72
Lateral load (kips)
Drift ratio (%)

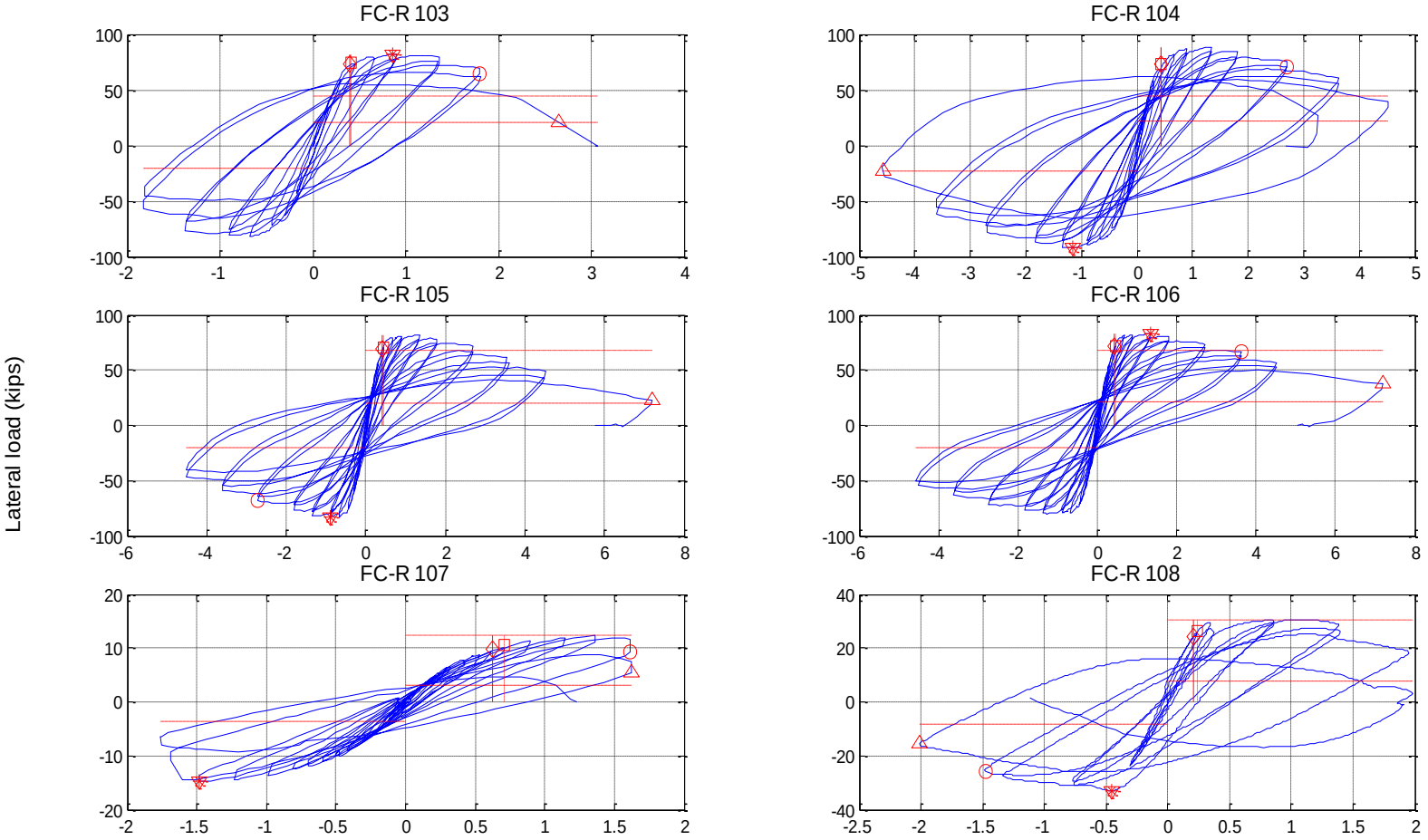

FC-R 73
FC-R 74
FC-R 75
FC-R 76
FC-R 77
FC-R 78
Lateral load (kips)
Drift ratio (%)

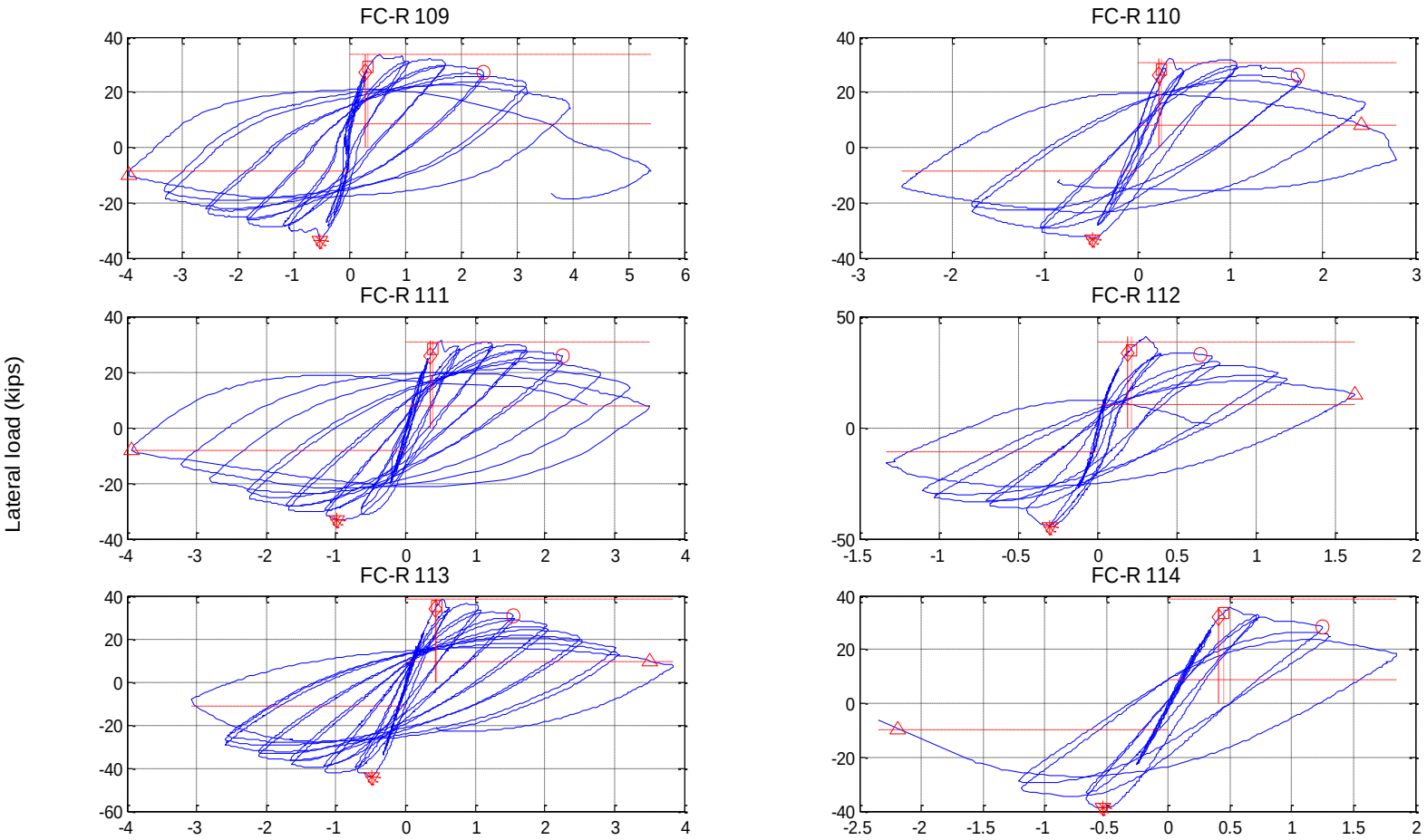

FC-R 79
FC-R 80
FC-R 81
FC-R 82
FC-R 83
FC-R 84
Lateral load (kips)
Drift ratio (%)

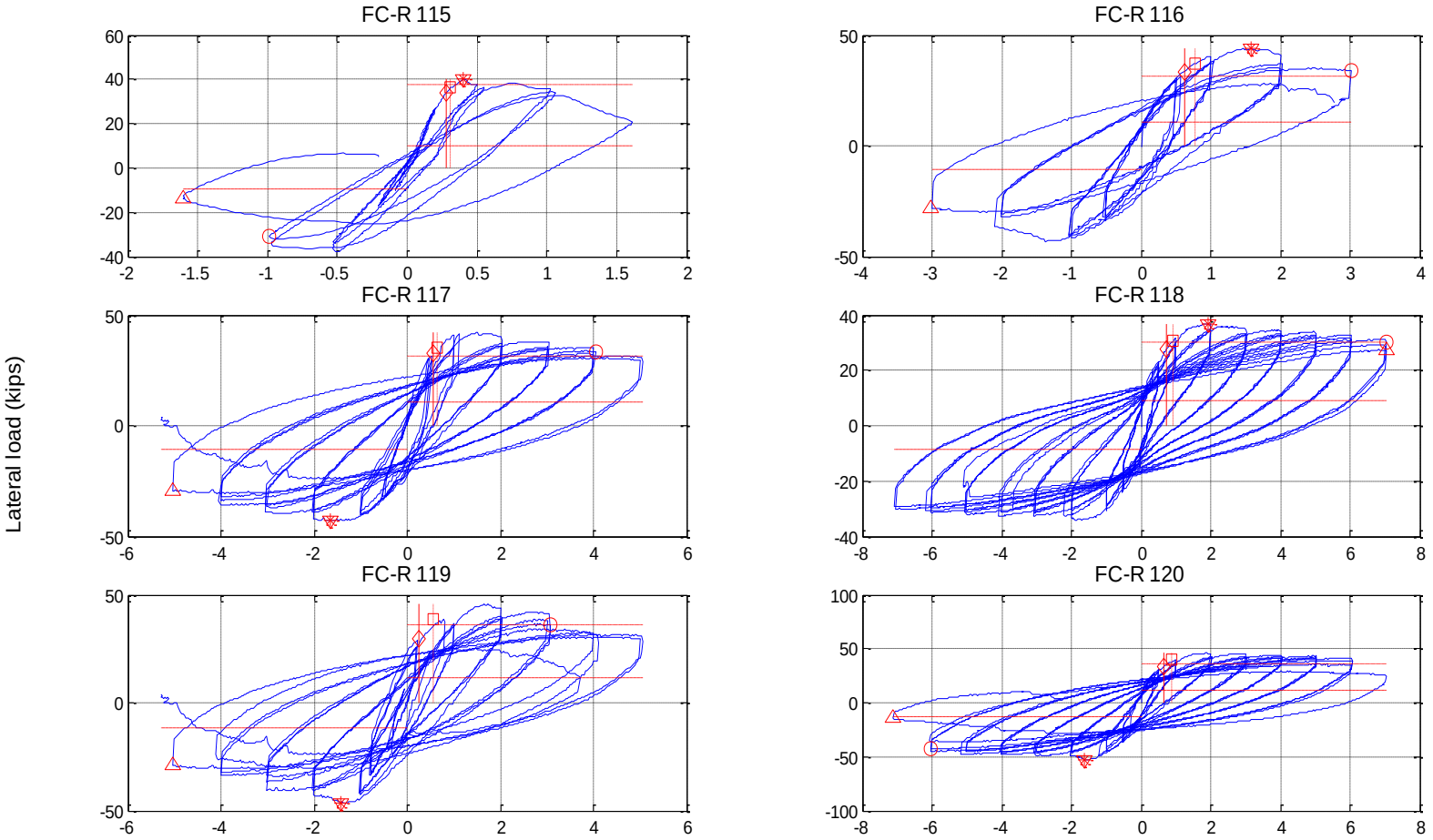

FC-R 85
FC-R 86
FC-R 87
FC-R 88
FC-R 89
FC-R 90
Lateral load (kips)
Drift ratio (%)

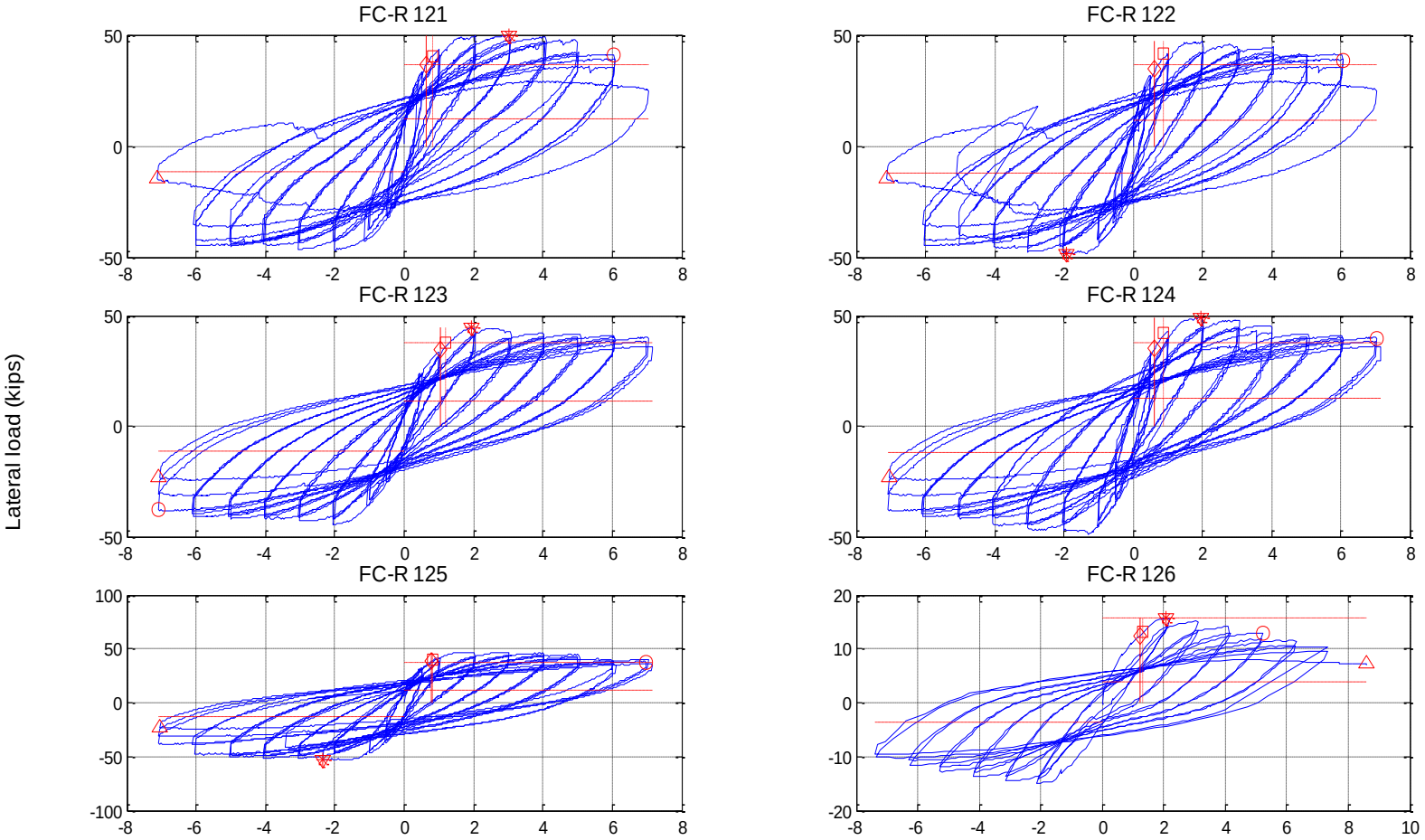

FC-R 91
FC-R 92
FC-R 93
FC-R 94
FC-R 95
FC-R 96
Lateral load (kips)
Drift ratio (%)

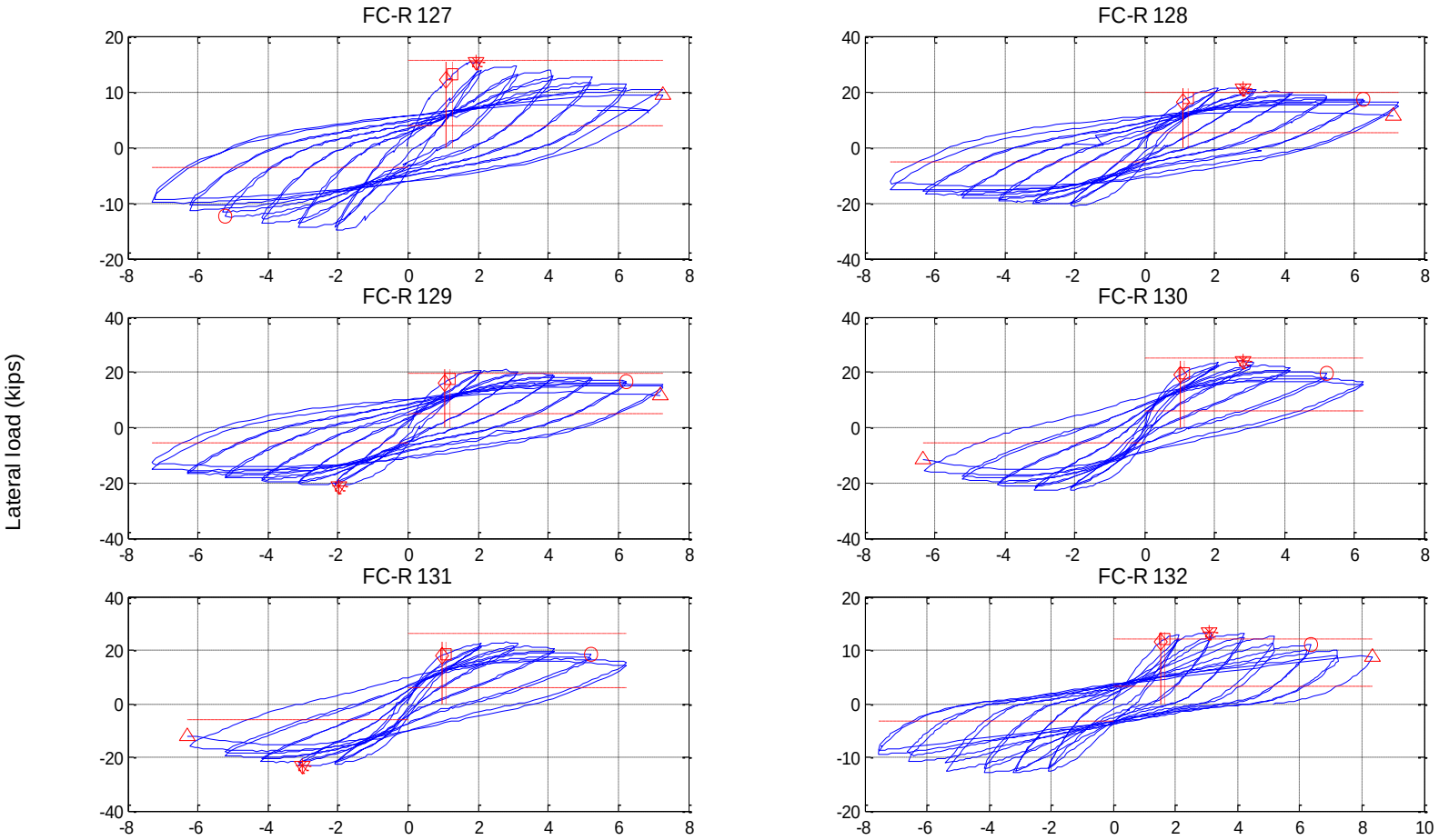

FC-R 97
FC-R 98
FC-R 99
FC-R 100
FC-R 101
FC-R 102
Lateral load (kips)
Drift ratio (%)

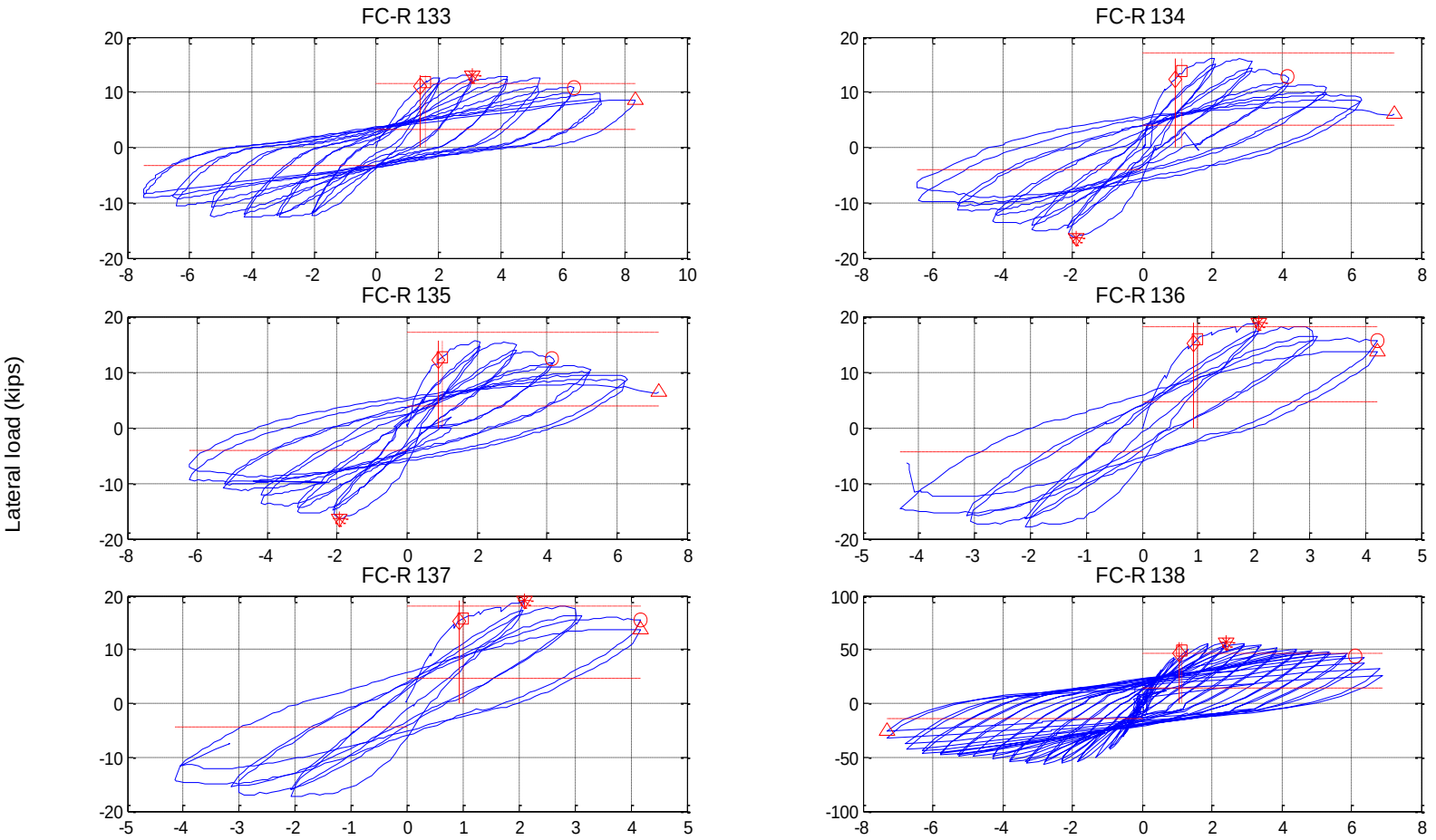

FC-R 103
FC-R 104
FC-R 105
FC-R 106
FC-R 107
FC-R 108
Lateral load (kips)
Drift ratio (%)

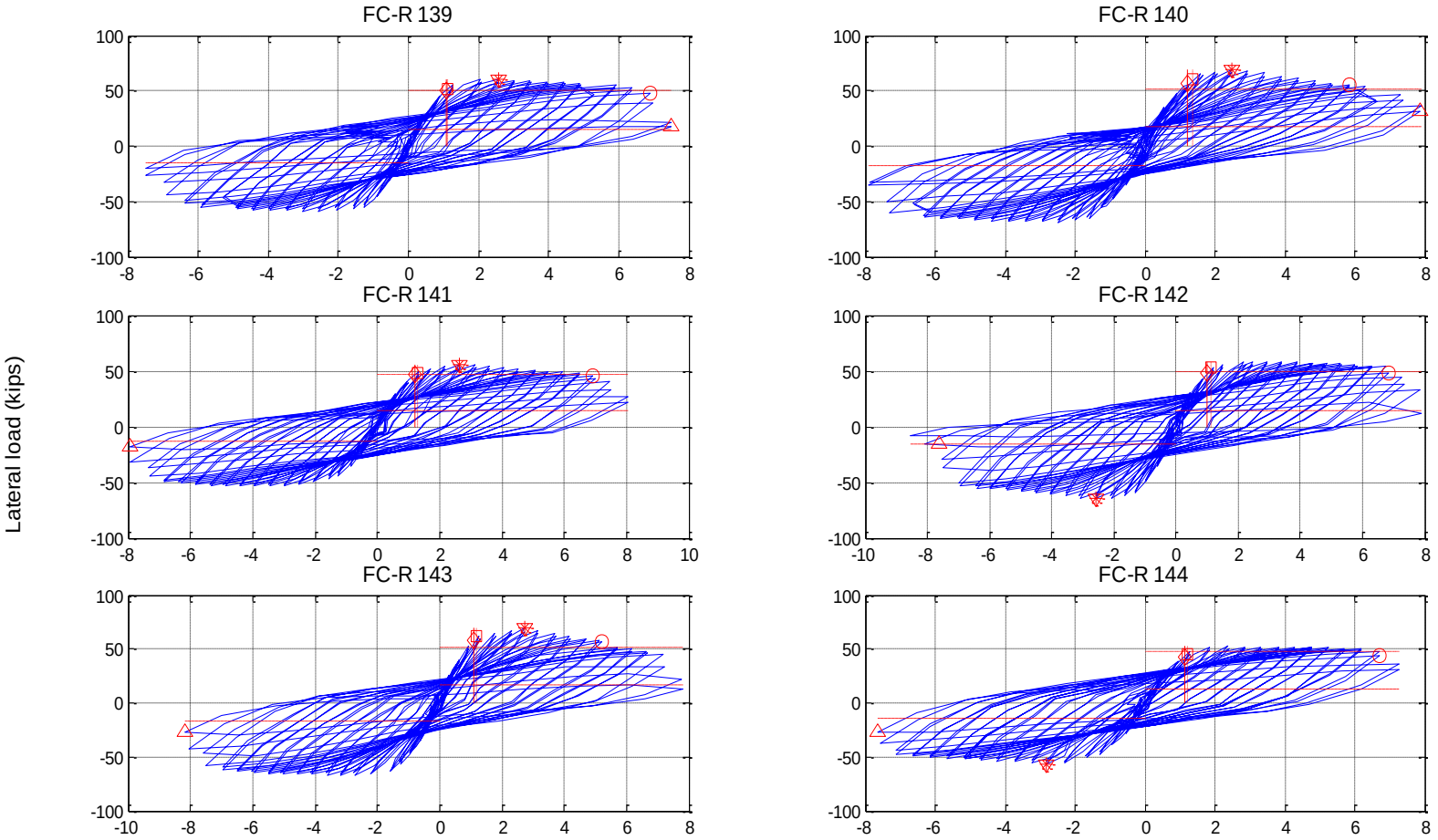

FC-R 109
FC-R 110
FC-R 111
FC-R 112
FC-R 113
FC-R 114
Lateral load (kips)
Drift ratio (%)

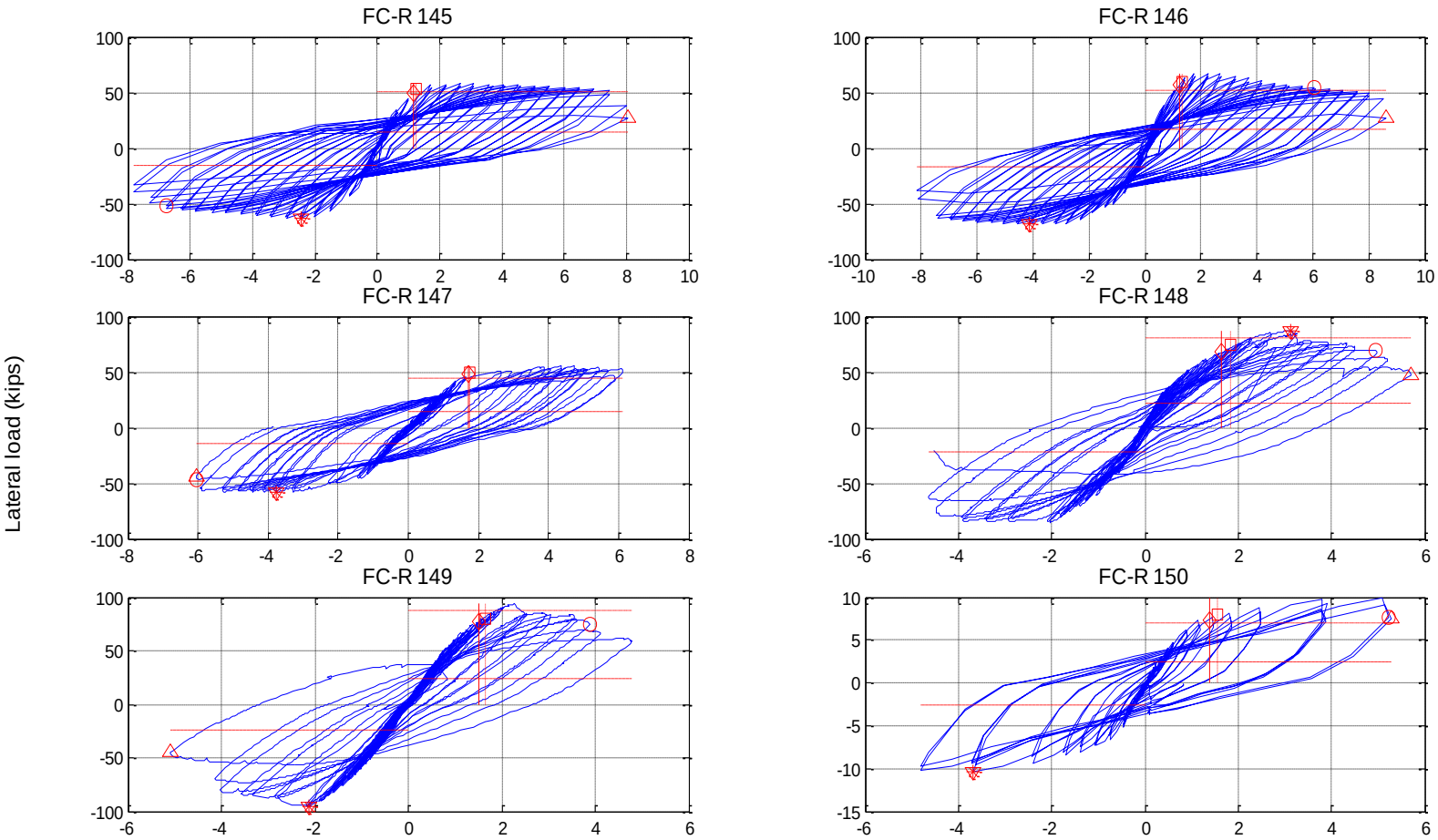

FC-R 115
FC-R 116
FC-R 117
FC-R 118
FC-R 119
FC-R 120
Lateral load (kips)
Drift ratio (%)

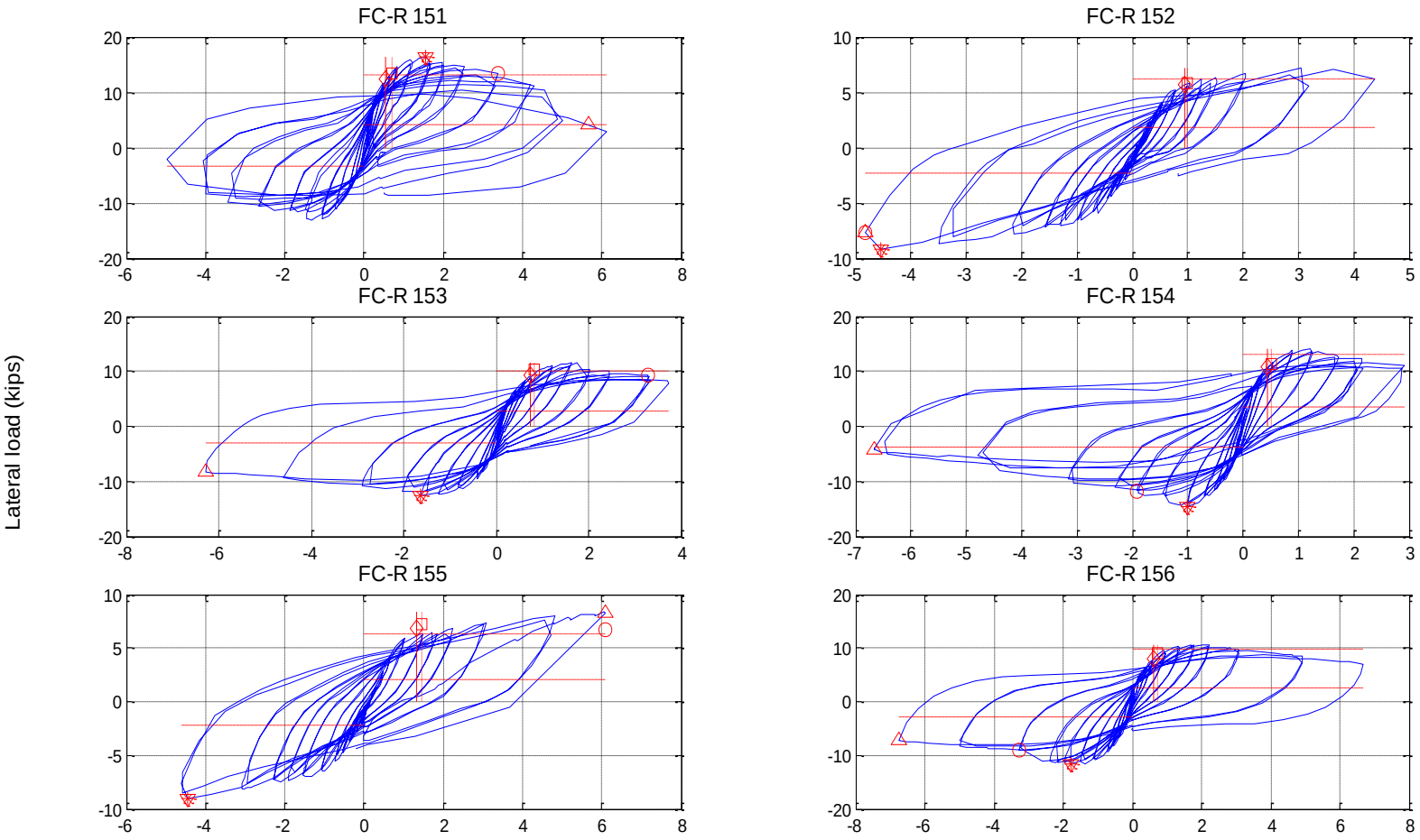

FC-R 121
FC-R 122
FC-R 123
FC-R 124
FC-R 125
FC-R 126
Lateral load (kips)
Drift ratio (%)

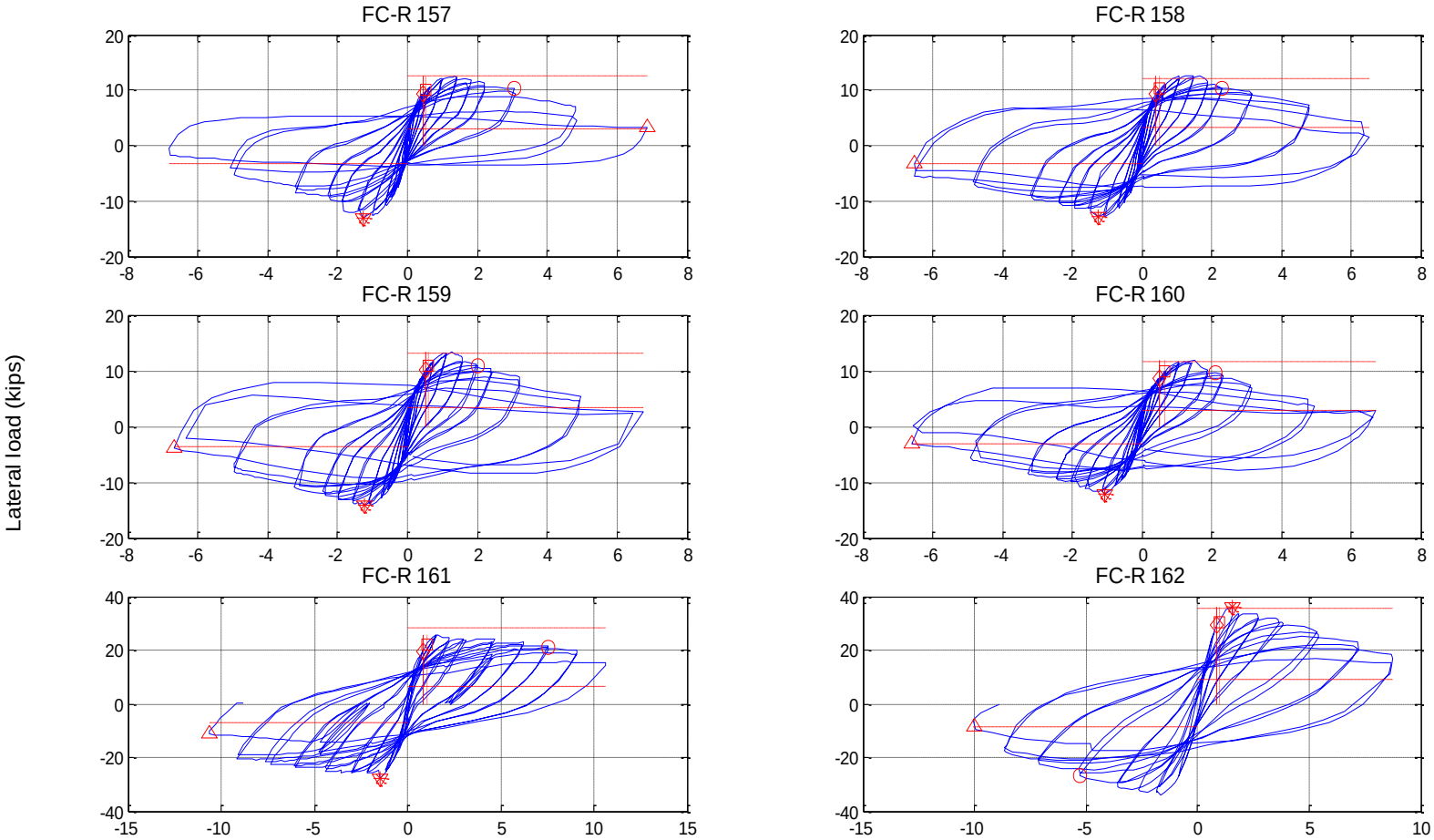

FC-R 127
FC-R 128
FC-R 129
FC-R 130
FC-R 131
FC-R 132
Lateral load (kips)
Drift ratio (%)

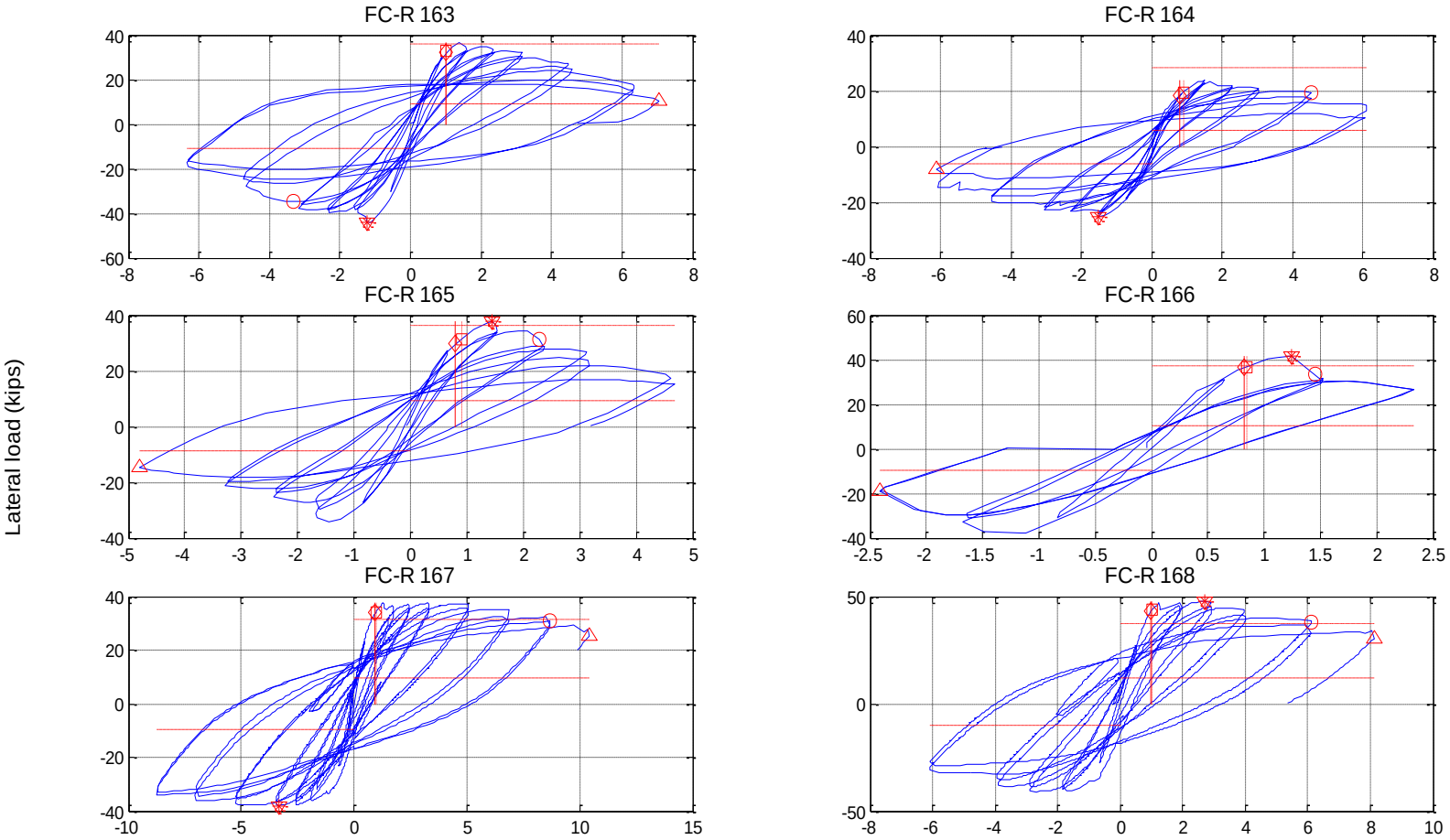

FC-R 133
FC-R 134
FC-R 135
FC-R 136
FC-R 137
FC-R 138
Lateral load (kips)
Drift ratio (%)

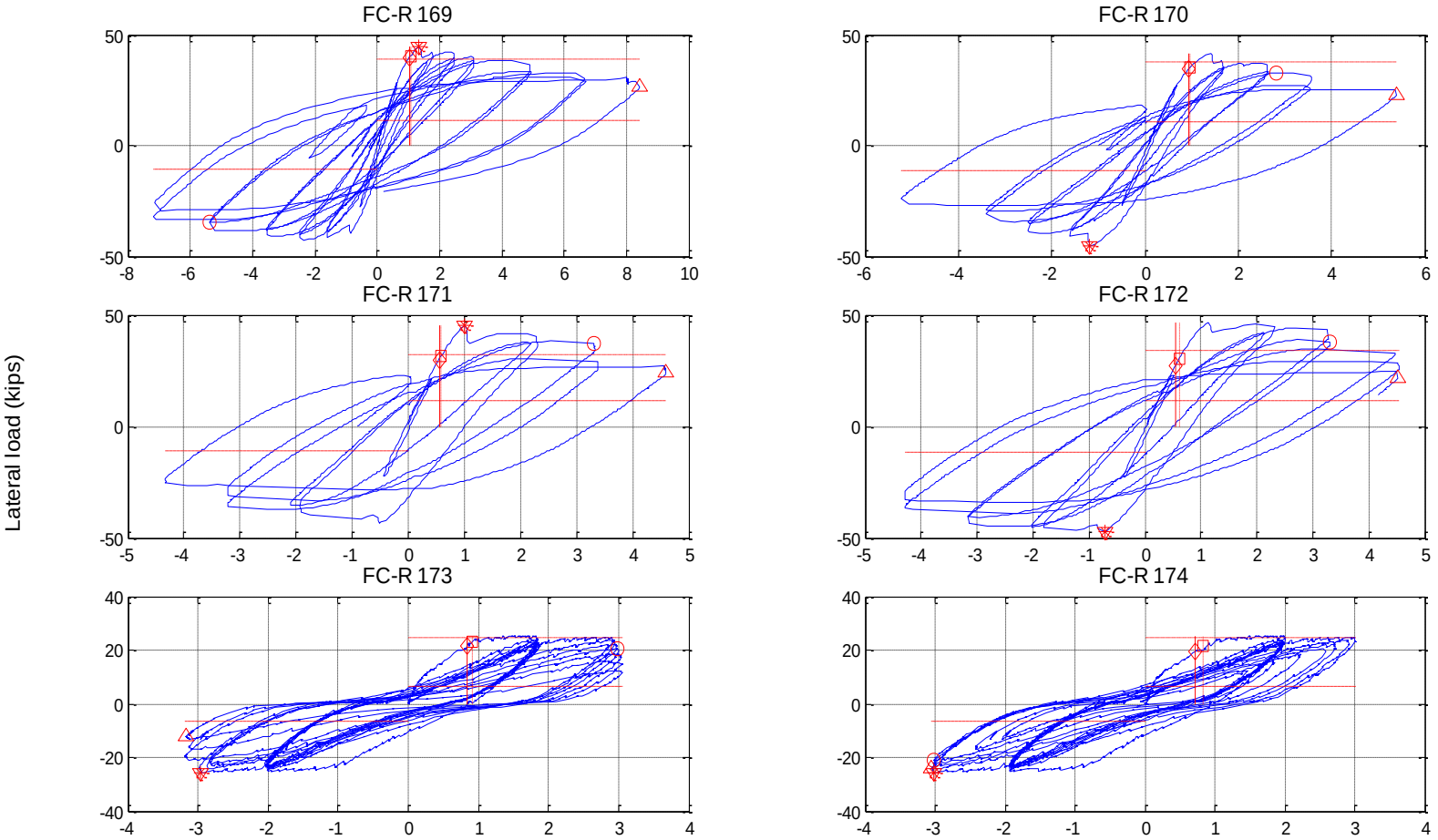

FC-R 139
FC-R 140
FC-R 141
FC-R 142
FC-R 143
FC-R 144
Lateral load (kips)
Drift ratio (%)

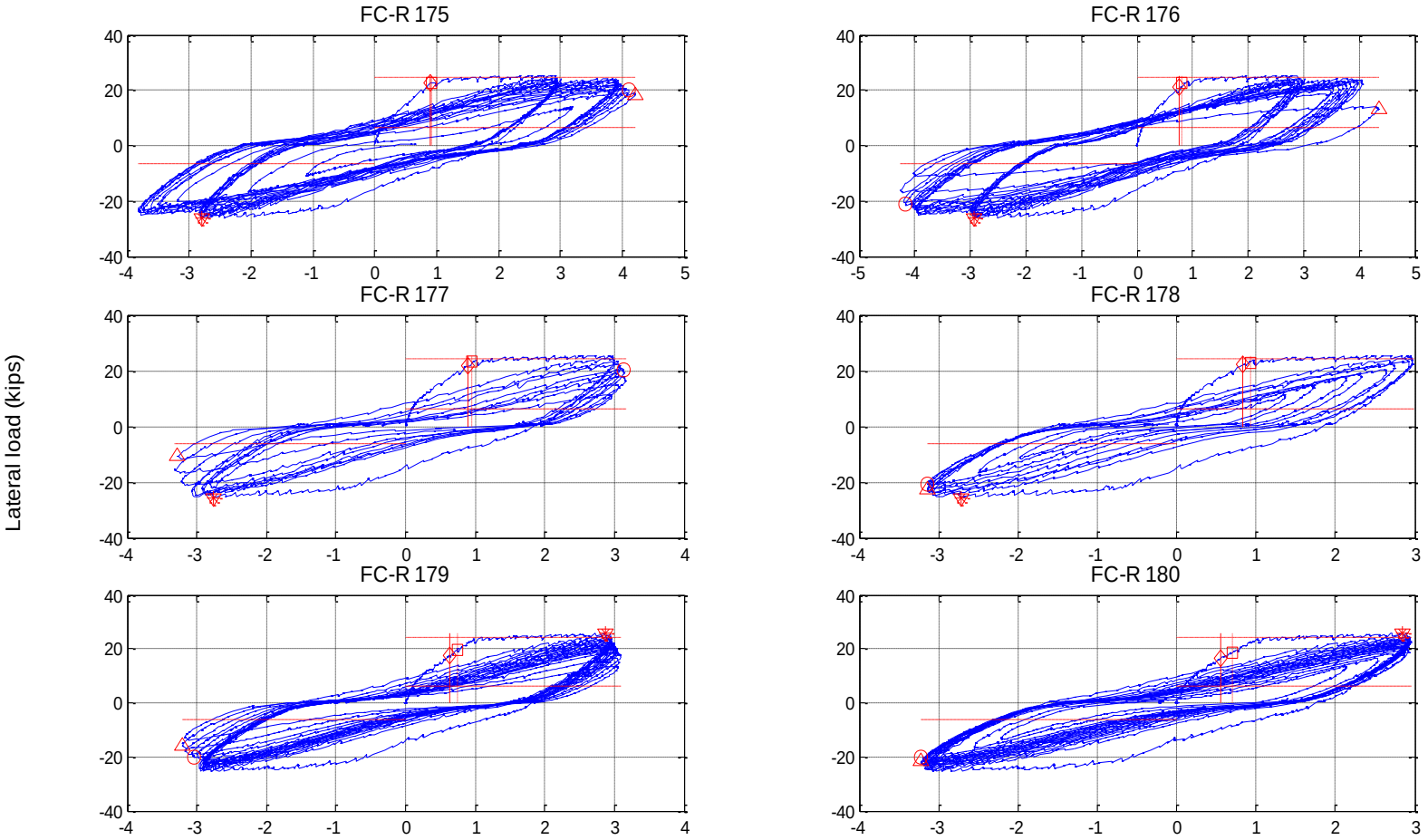

FC-R 145
FC-R 146
FC-R 147
FC-R 148
FC-R 149
FC-R 150
Lateral load (kips)
Drift ratio (%)

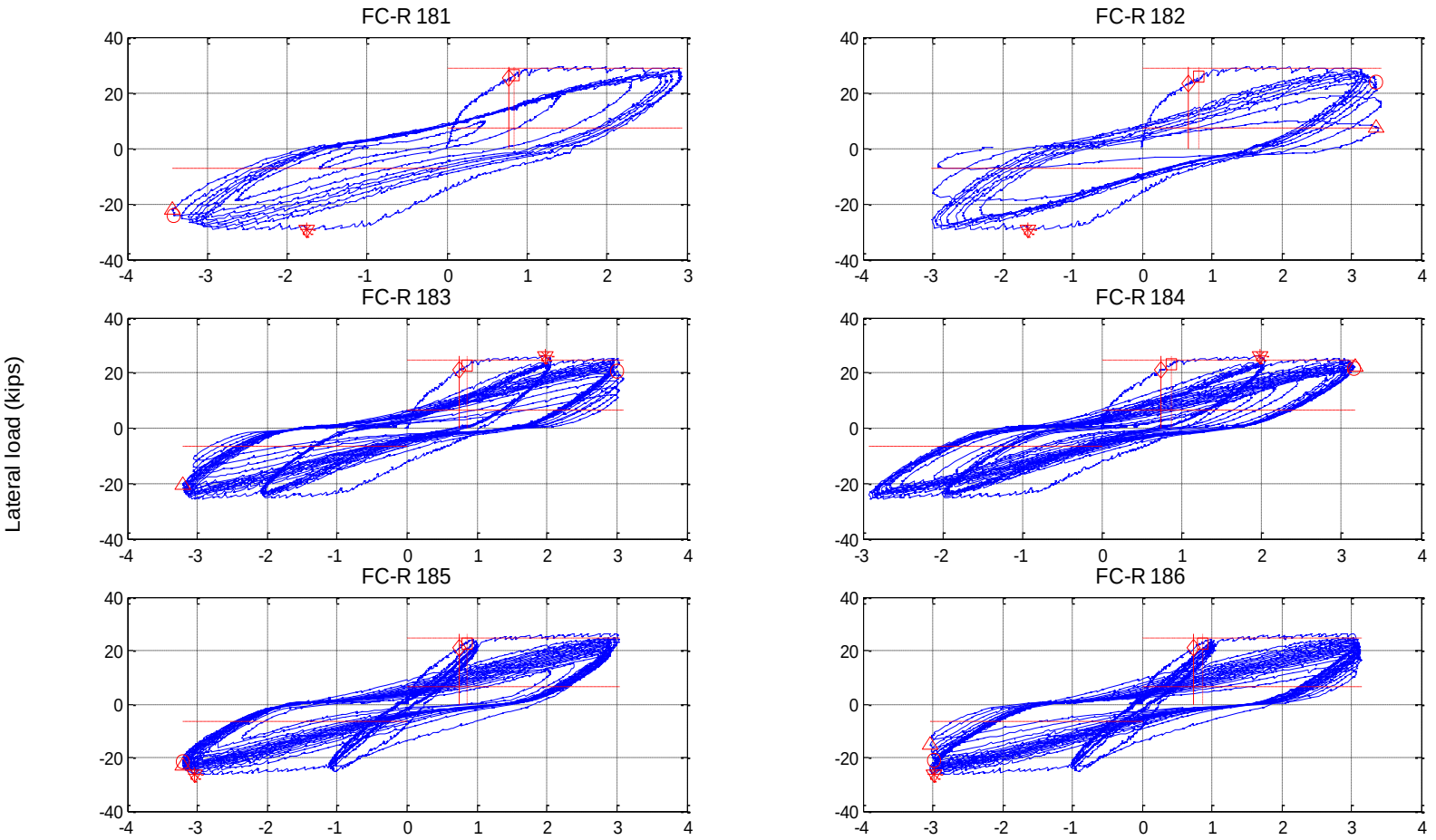

FC-R 151
FC-R 152
FC-R 153
FC-R 154
FC-R 155
FC-R 156
Lateral load (kips)
Drift ratio (%)

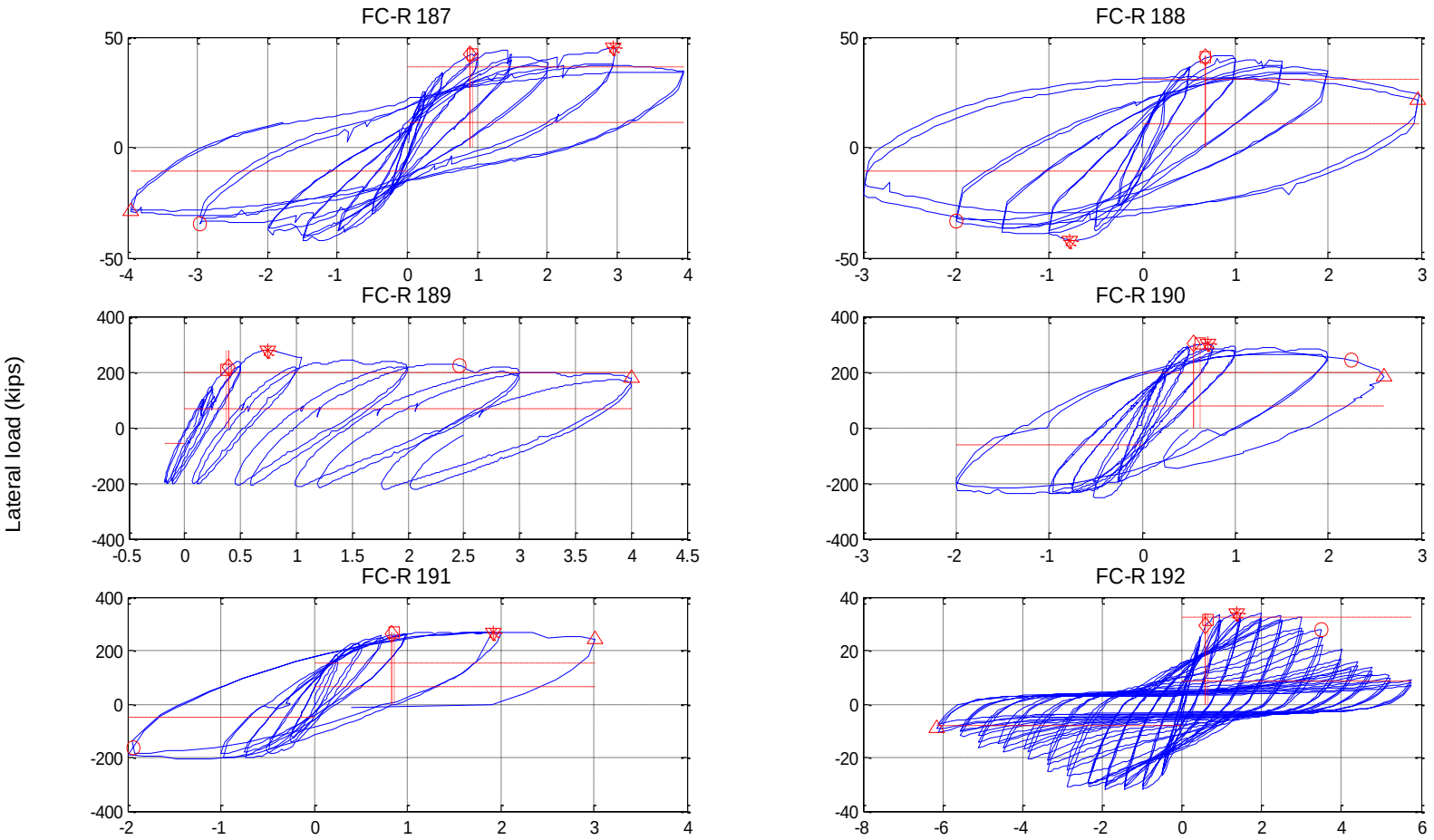

FC-R 157
FC-R 158
FC-R 159
FC-R 160
FC-R 161
FC-R 162
Lateral load (kips)
Drift ratio (%)


FC-R 163
FC-R 164
FC-R 165
FC-R 166
FC-R 167
FC-R 168
Lateral load (kips)
Drift ratio (%)


FC-R 169
FC-R 170
FC-R 171
FC-R 172
FC-R 173
FC-R 174
Lateral load (kips)
Drift ratio (%)


FC-R 175
FC-R 176
FC-R 177
FC-R 178
FC-R 179
FC-R 180
Lateral load (kips)
Drift ratio (%)


FC-R 181
FC-R 182
FC-R 183
FC-R 184
FC-R 185
FC-R 186
Lateral load (kips)
Drift ratio (%)


FC-R 187
FC-R 188
FC-R 189
FC-R 190
FC-R 191
FC-R 192
Lateral load (kips)
Drift ratio (%)

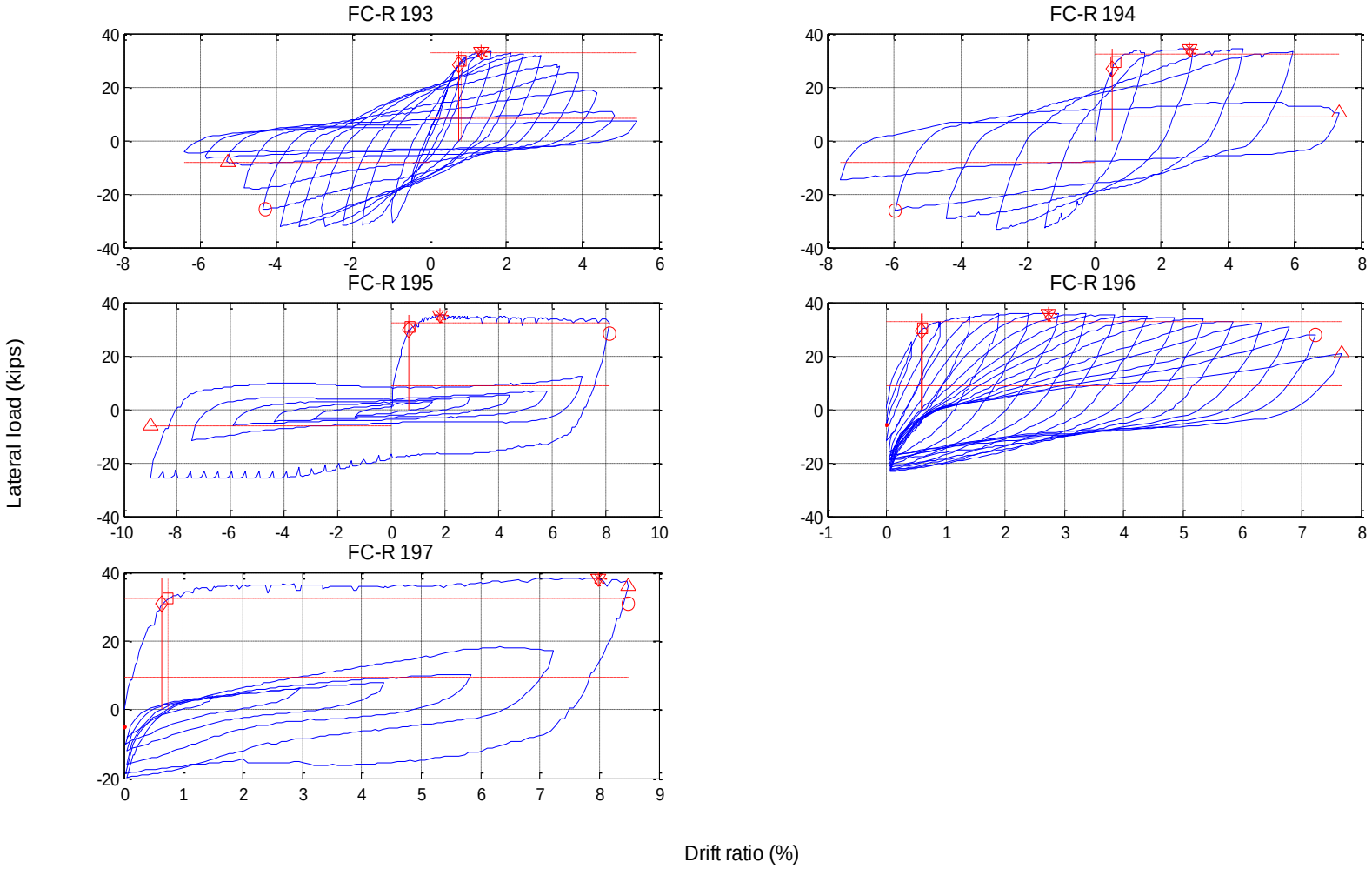
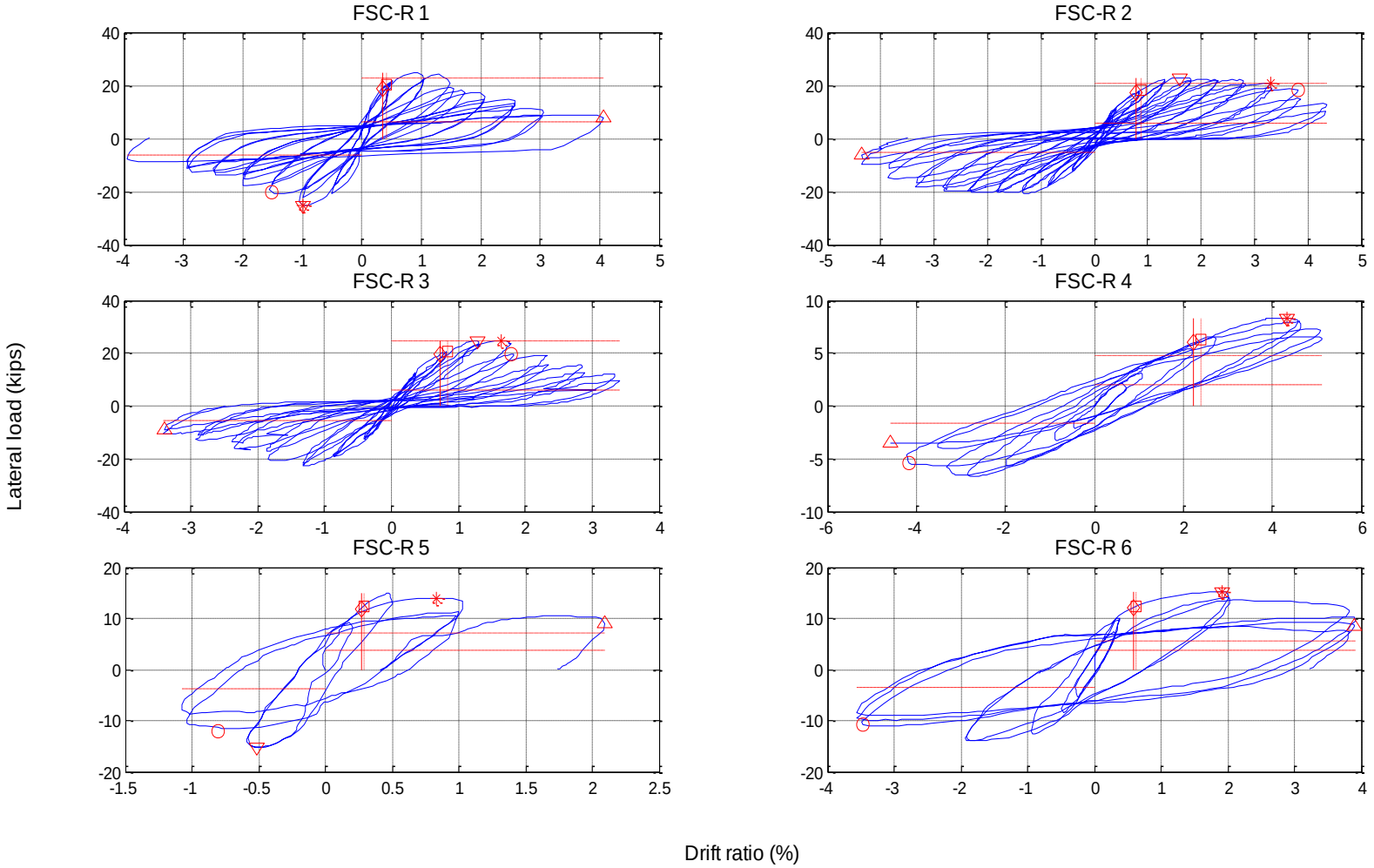
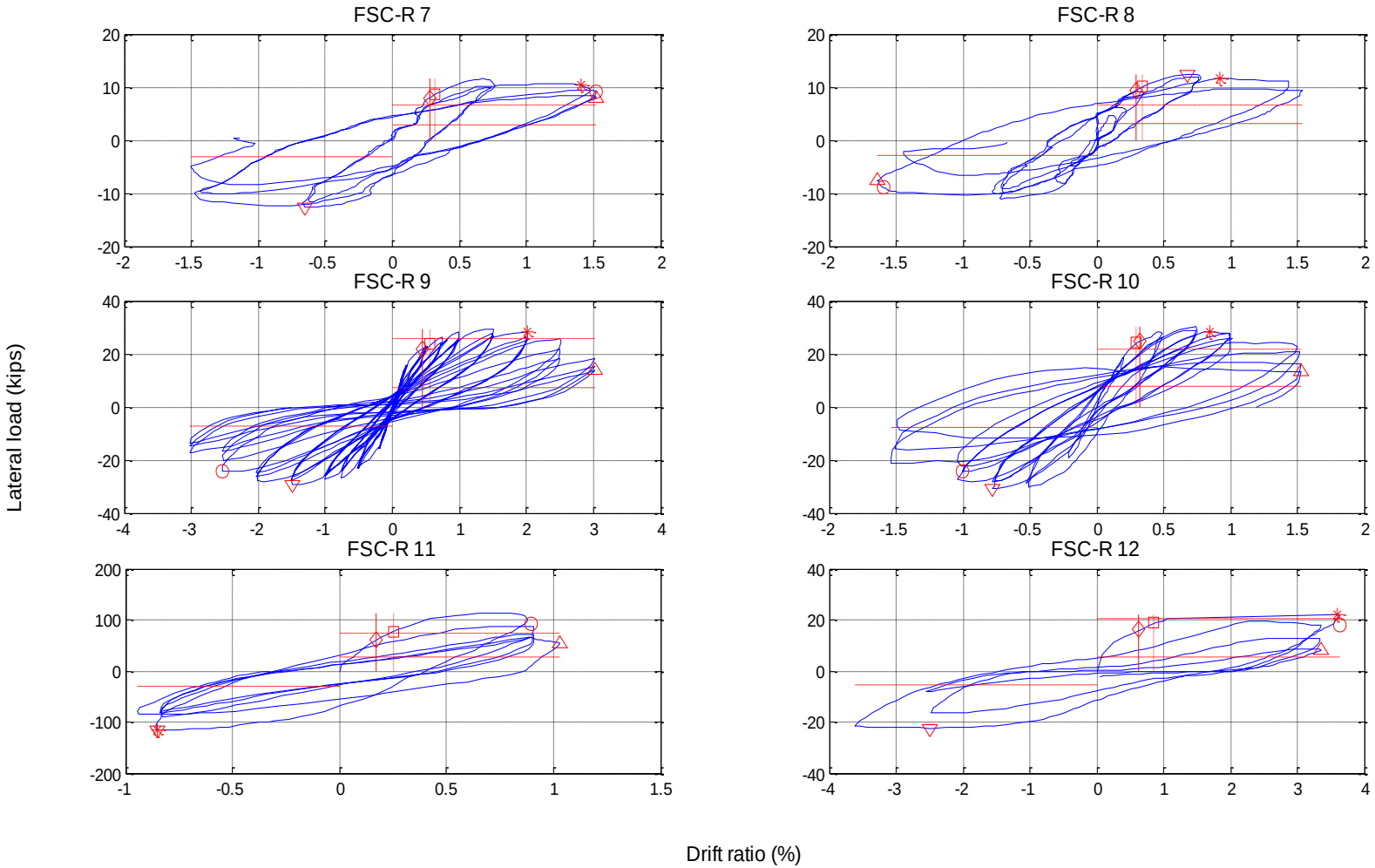
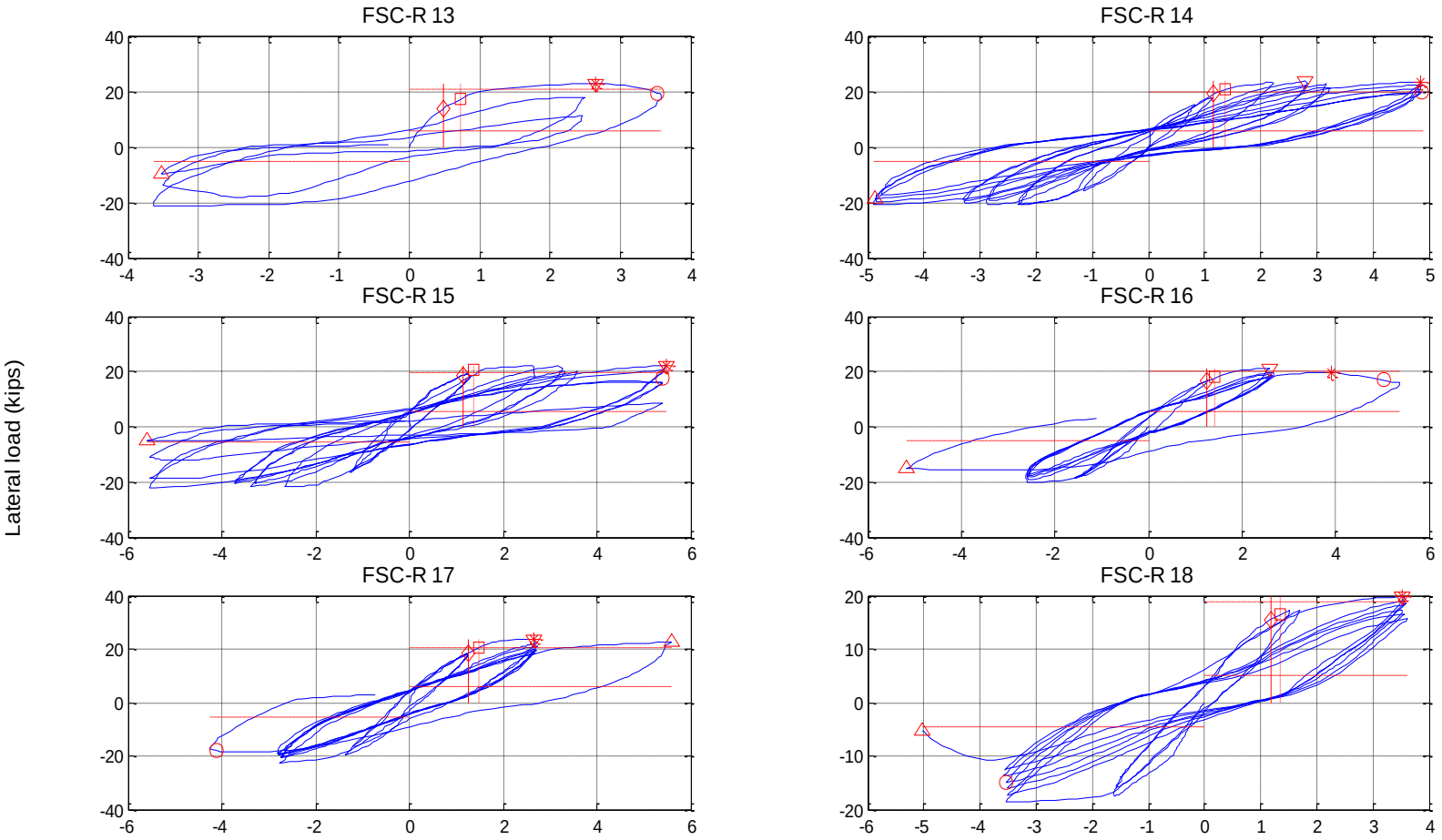
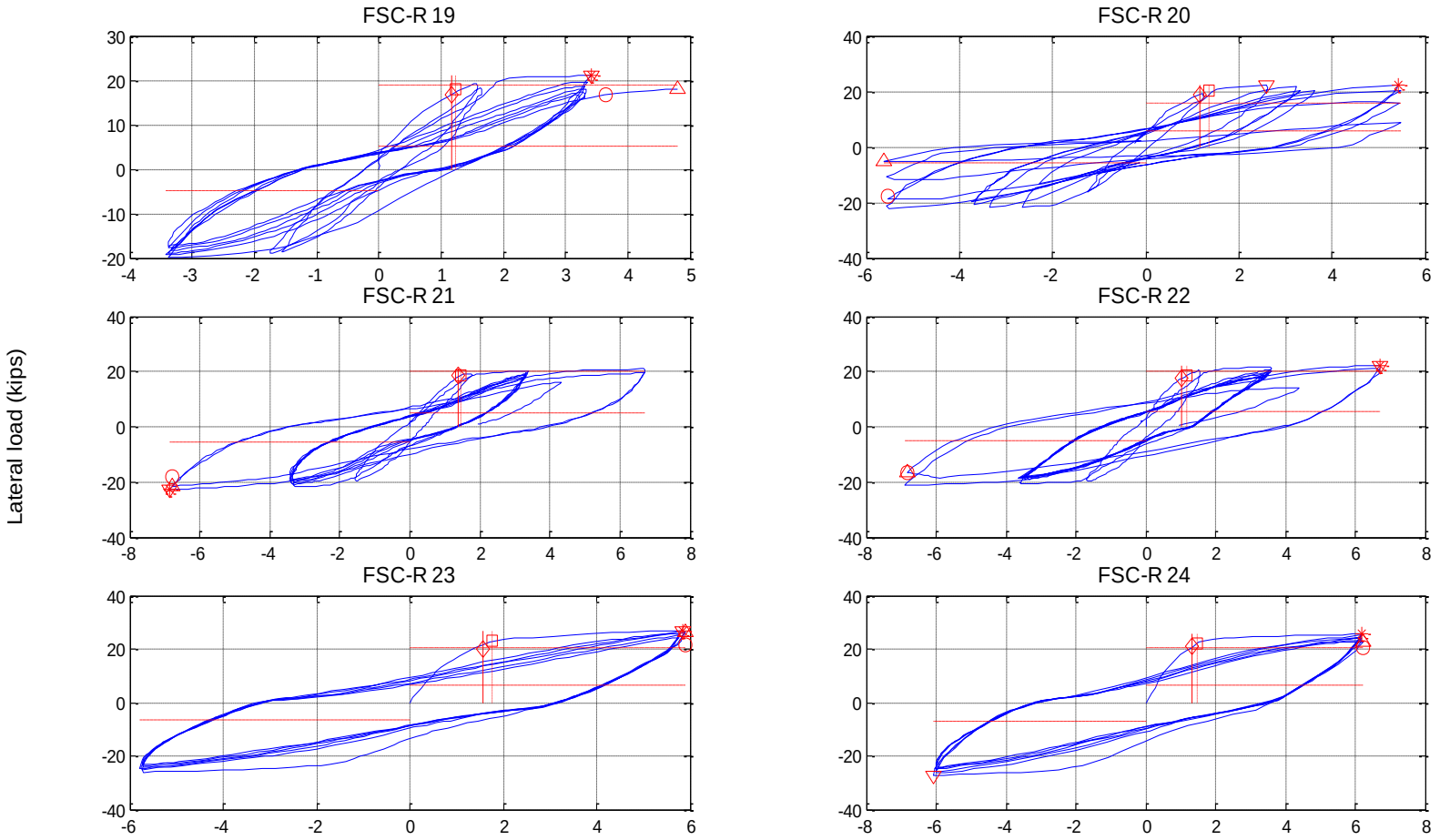

FC-R 193
FC-R 194
FC-R 195
FC-R 196
FC-R 197
Lateral load (kips)
Drift ratio (%)

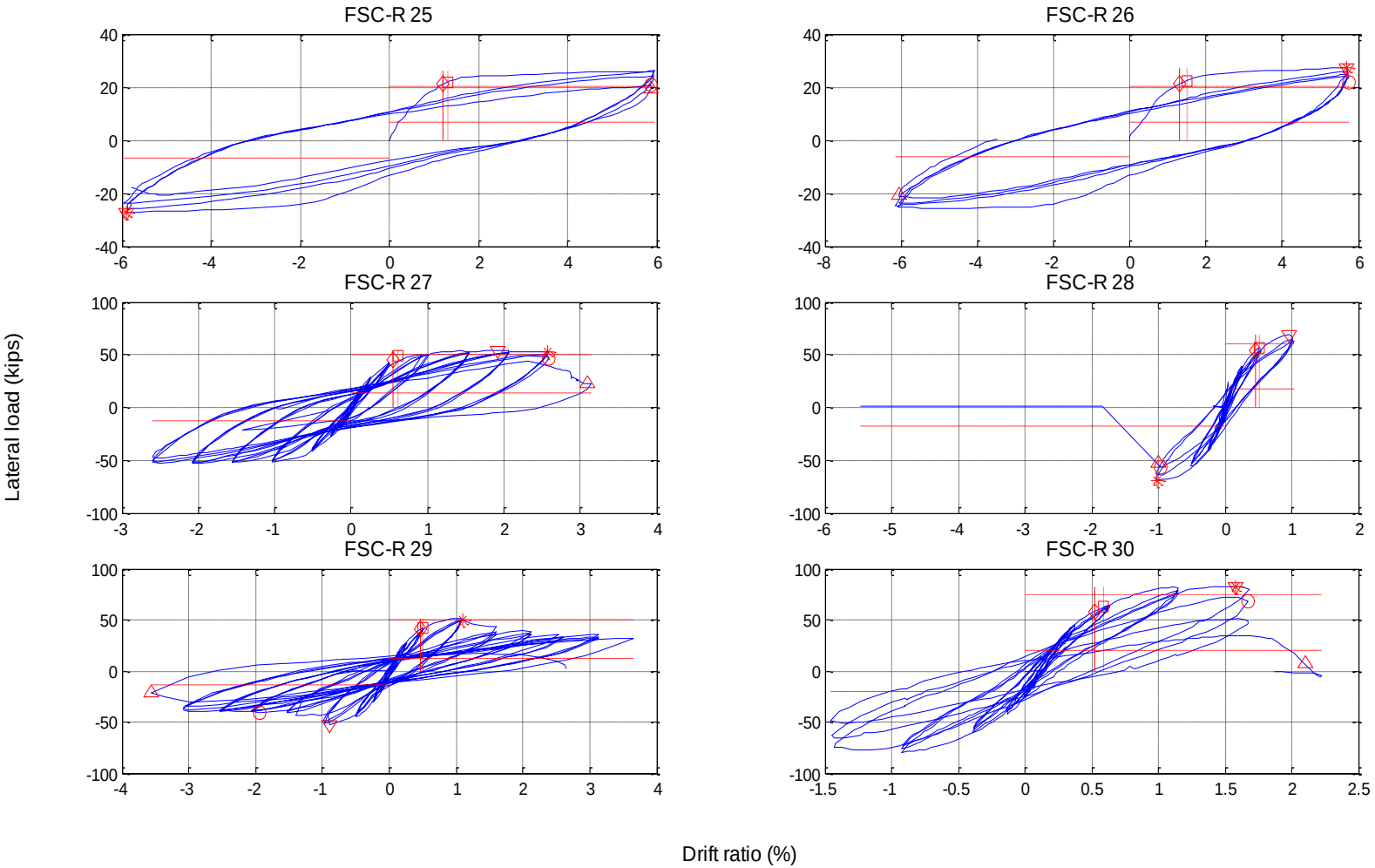
Figure B.2: Force-displacement plots of FSC-R columns

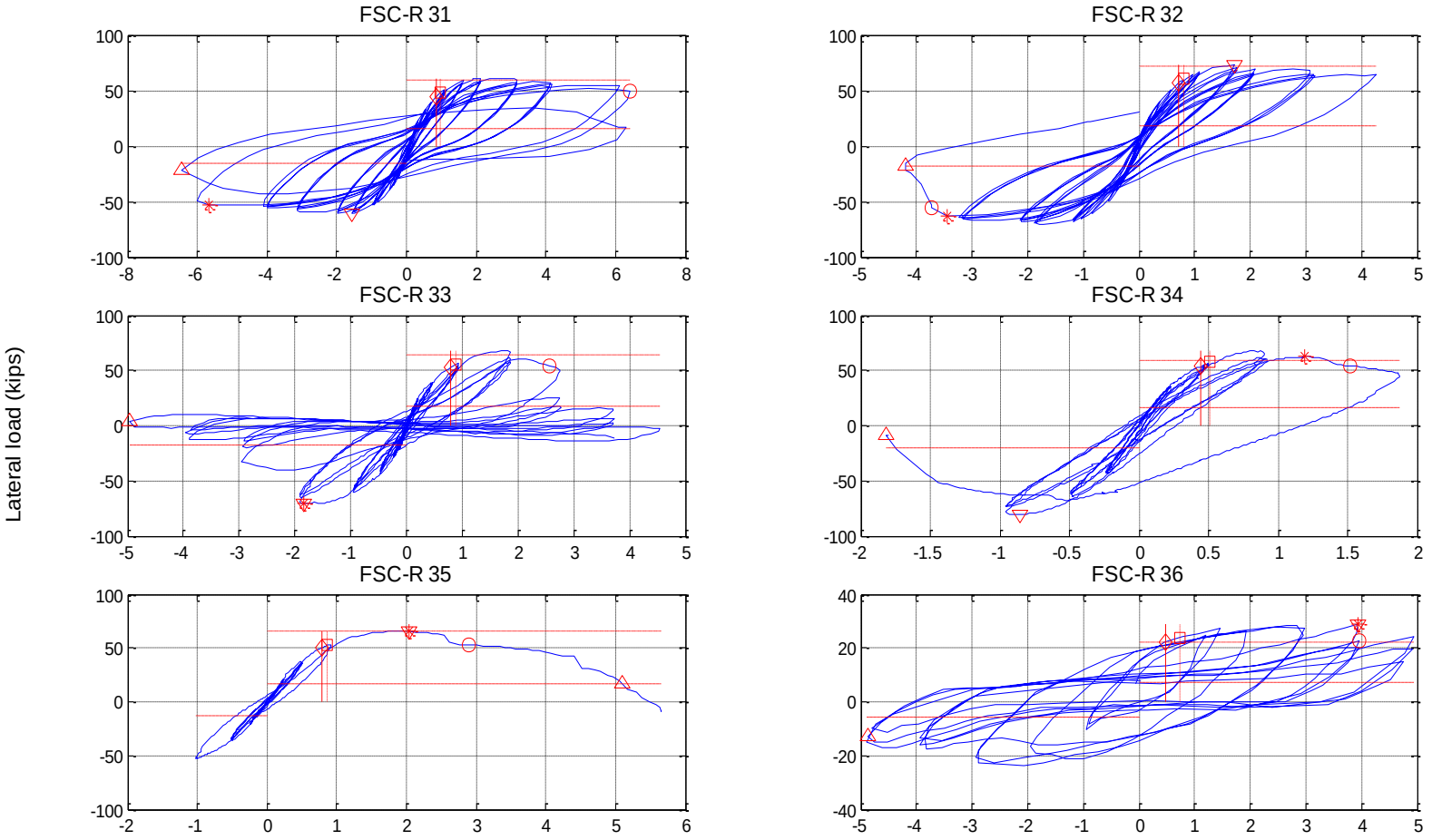


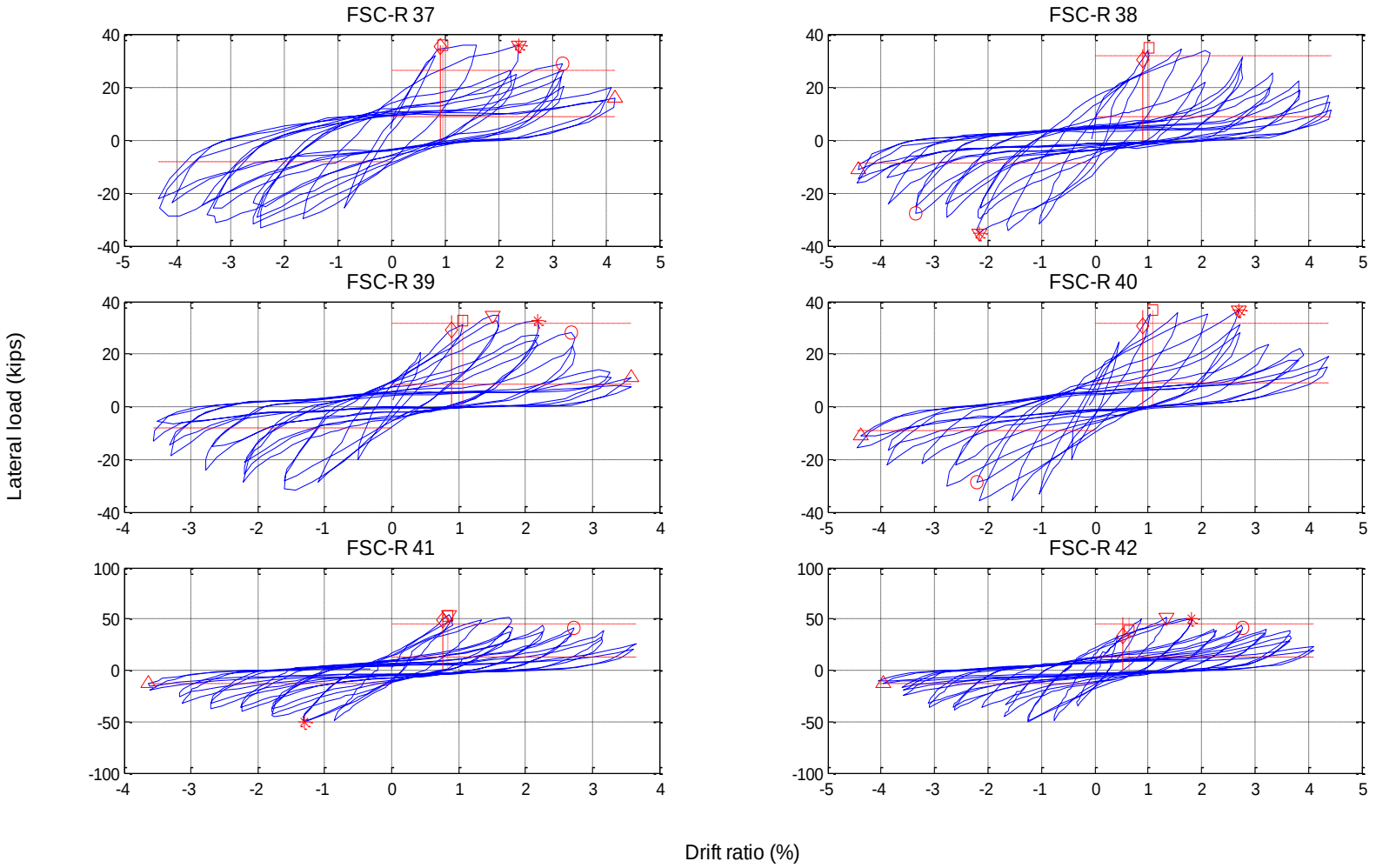

FSC-R 7
FSC-R 8
FSC-R 9
FSC-R 10
FSC-R 11
FSC-R 12
Lateral load (kips)
Drift ratio (%)

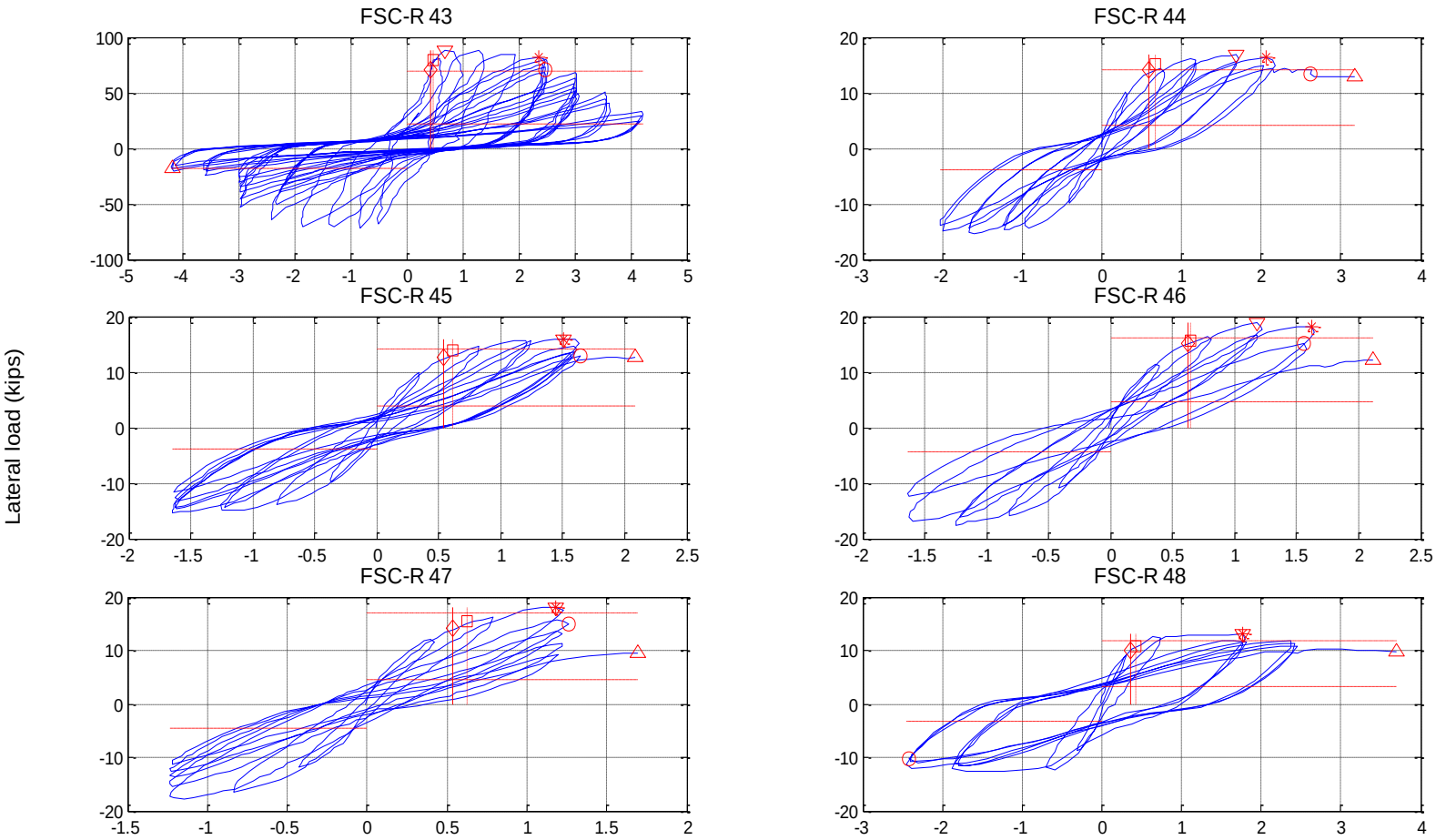

FSC-R 13
FSC-R 14
FSC-R 15
FSC-R 16
FSC-R 17
FSC-R 18
Lateral load (kips)
Drift ratio (%)

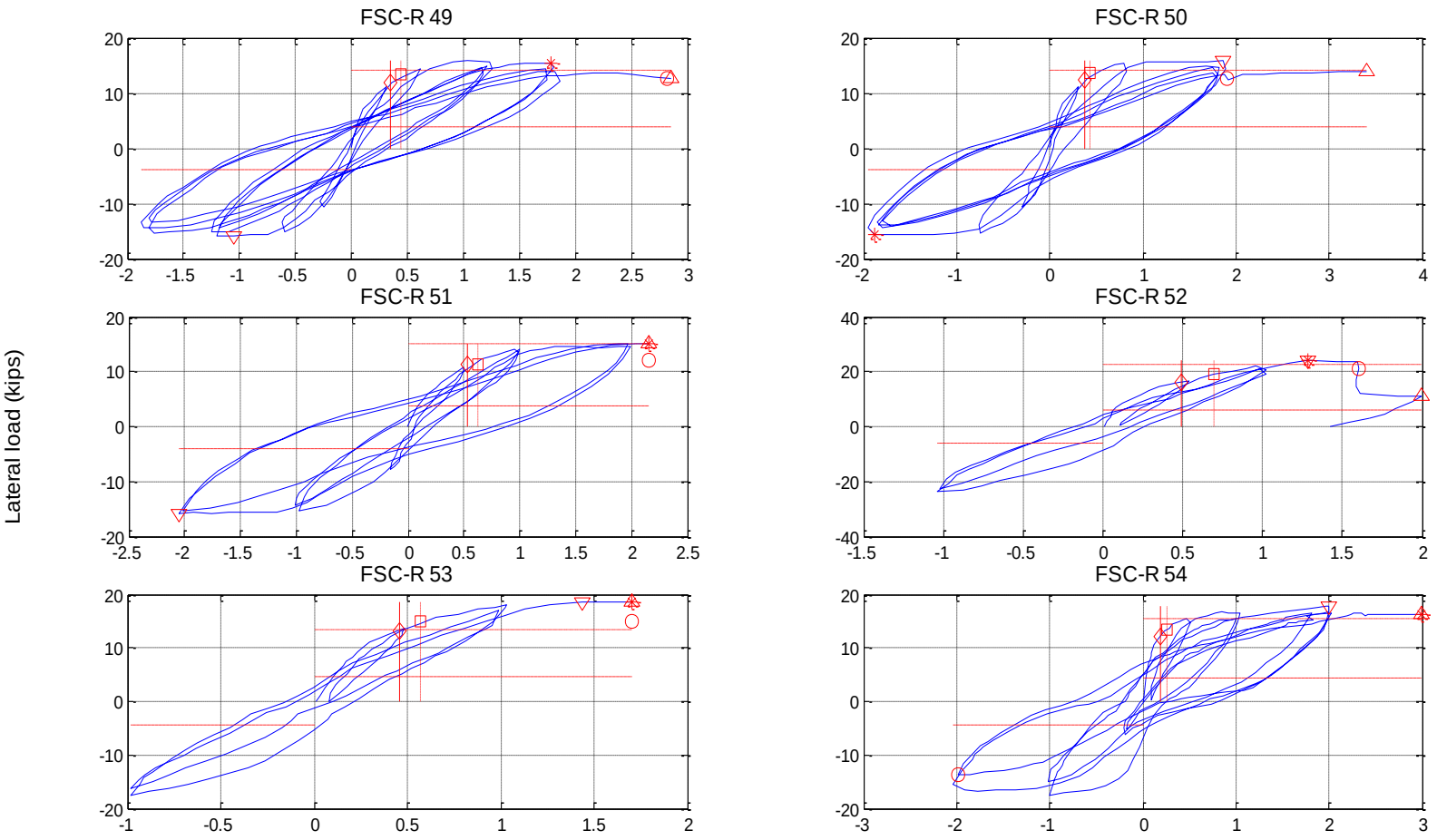

FSC-R 19
FSC-R 20
FSC-R 21
FSC-R 22
FSC-R 23
FSC-R 24
Lateral load (kips)
Drift ratio (%)

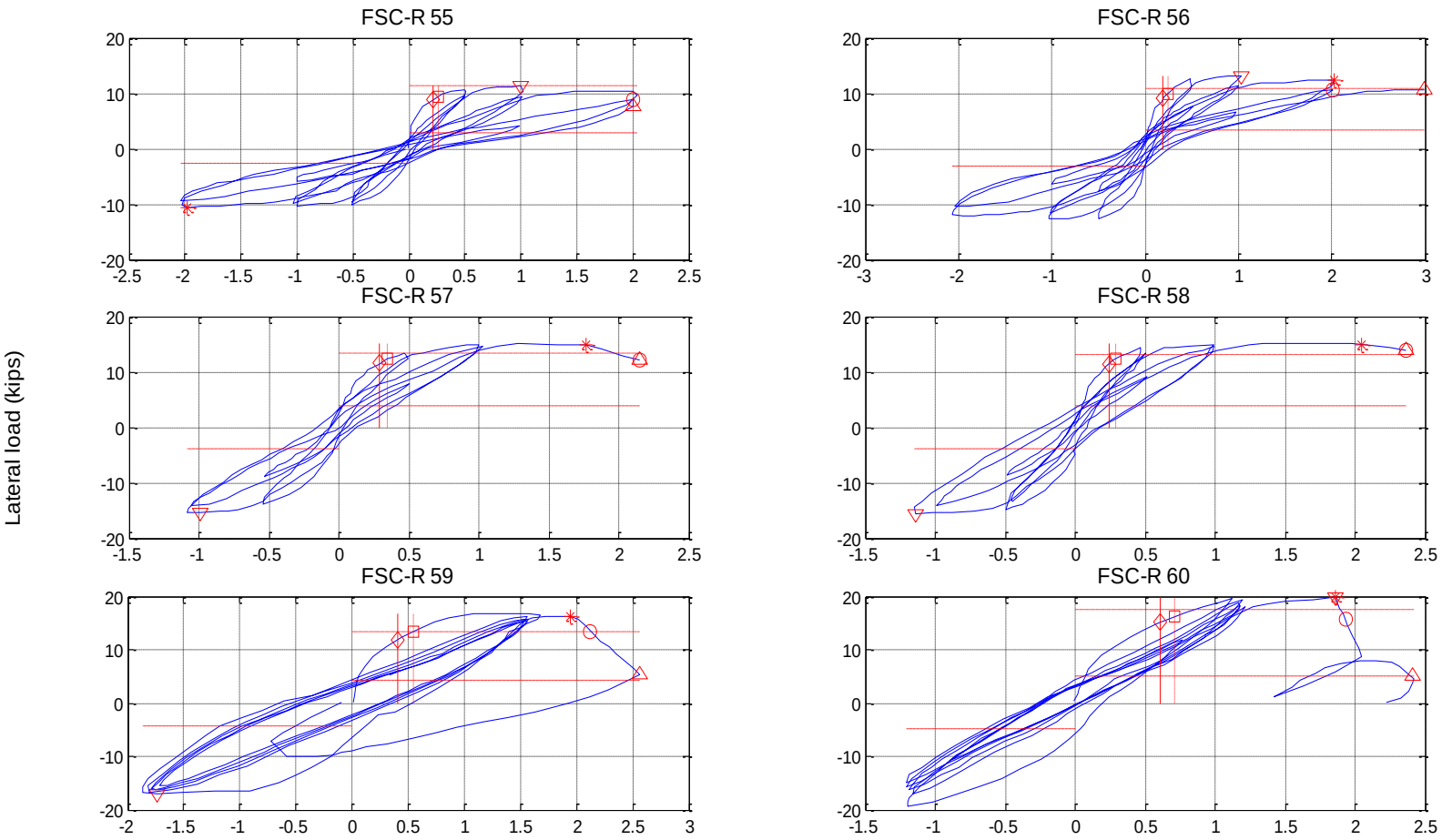

FSC-R 25
FSC-R 26
FSC-R 27
FSC-R 28
FSC-R 29
FSC-R 30
Lateral load (kips)
Drift ratio (%)

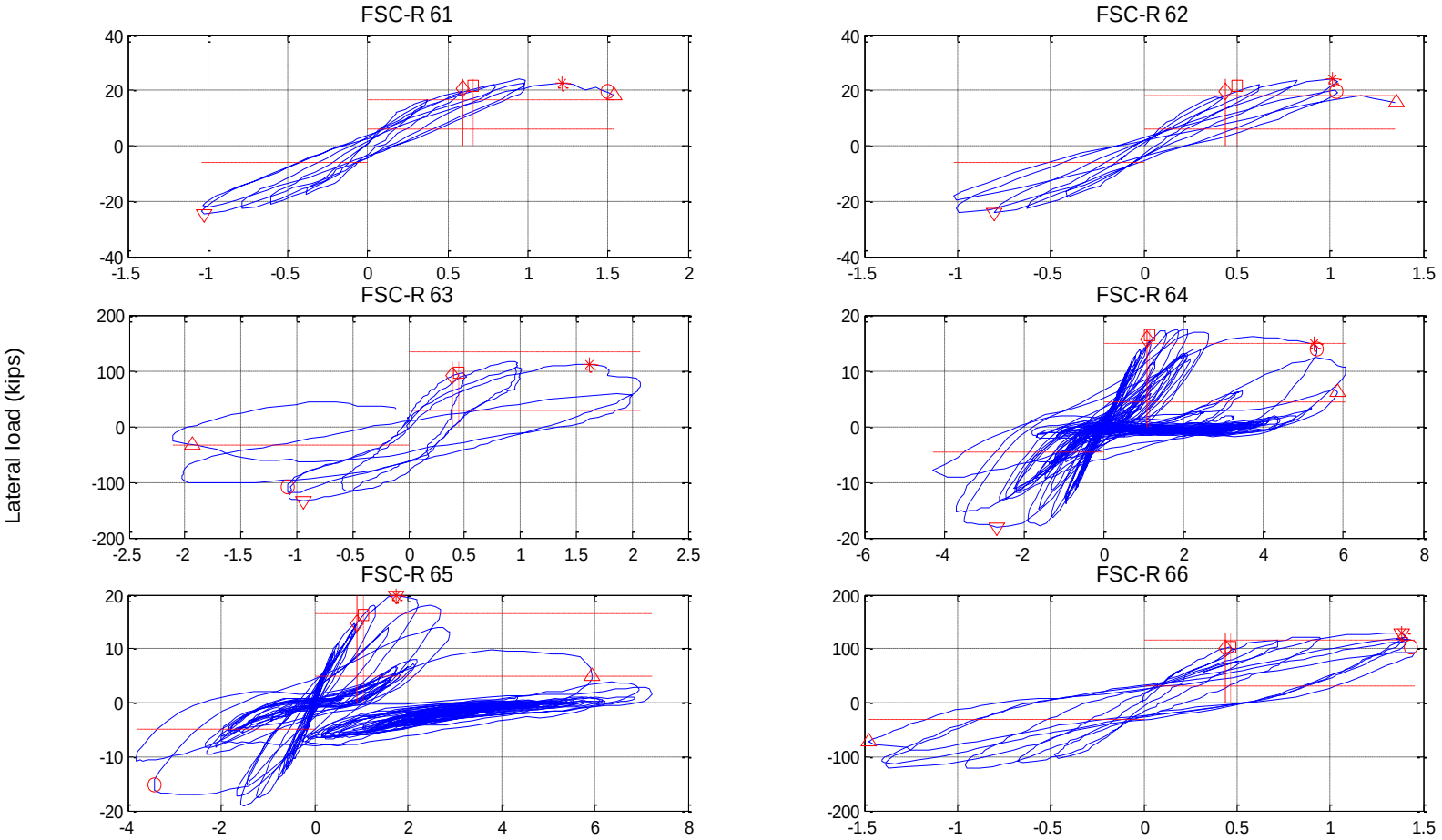

FSC-R 31
FSC-R 32
FSC-R 33
FSC-R 34
FSC-R 35
FSC-R 36
Lateral load (kips)
Drift ratio (%)

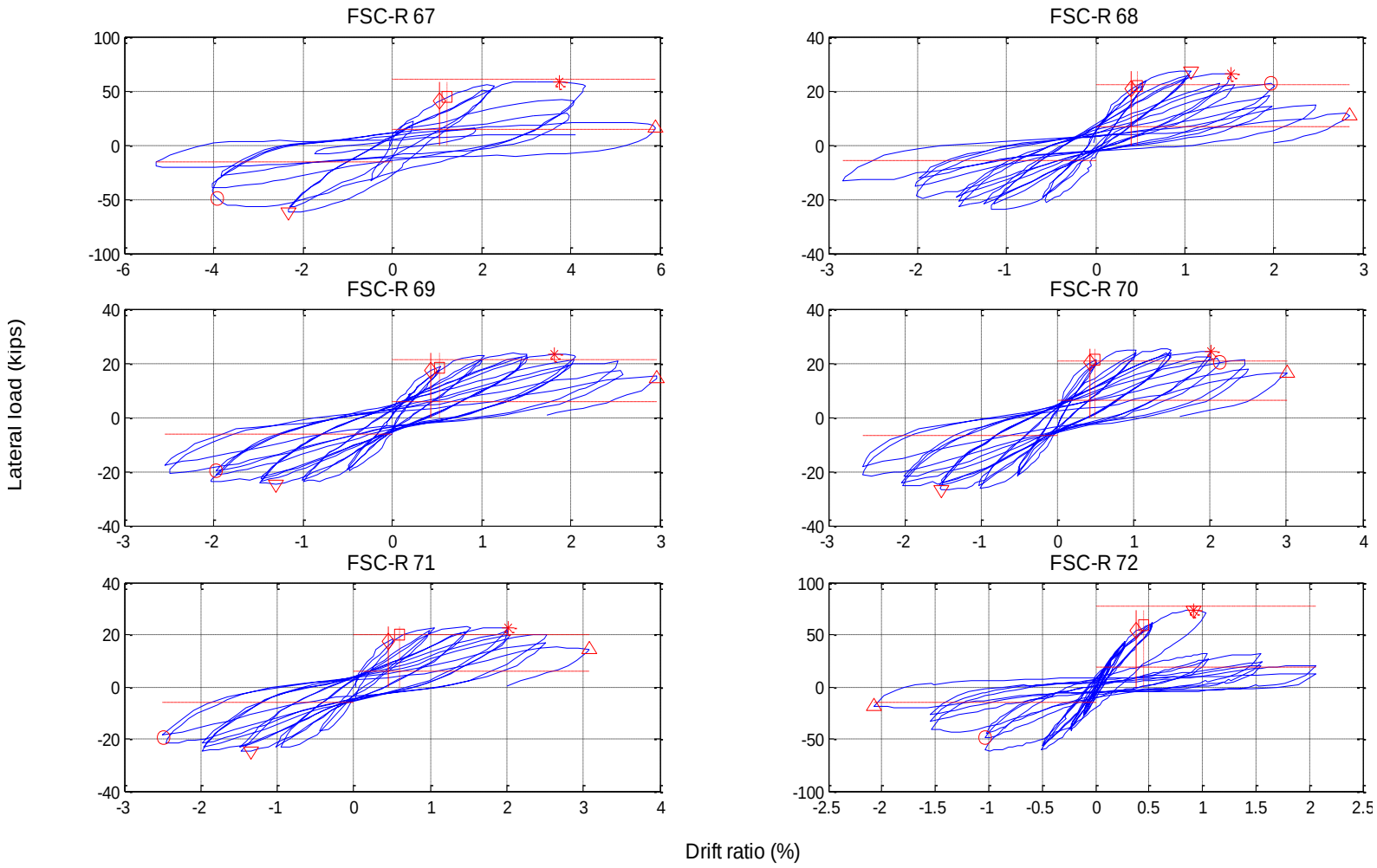

FSC-R 37
FSC-R 38
FSC-R 39
FSC-R 40
FSC-R 41
FSC-R 42
Lateral load (kips)
Drift ratio (%)

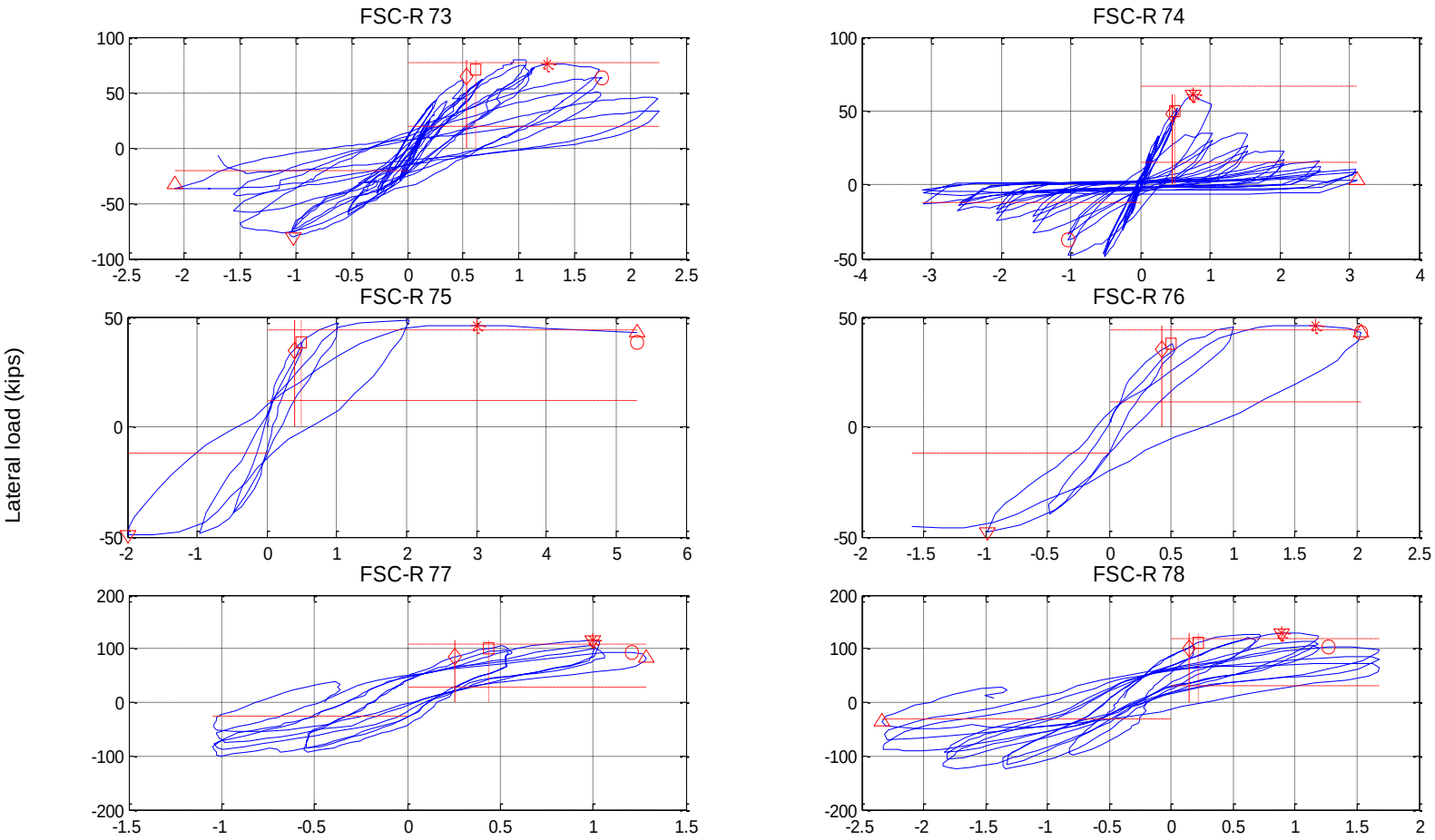

FSC-R 43
FSC-R 44
FSC-R 45
FSC-R 46
FSC-R 47
FSC-R 48
Lateral load (kips)
Drift ratio (%)


FSC-R 49
FSC-R 50
FSC-R 51
FSC-R 52
FSC-R 53
FSC-R 54
Lateral load (kips)
Drift ratio (%)


FSC-R 55
FSC-R 56
FSC-R 57
FSC-R 58
FSC-R 59
FSC-R 60
Lateral load (kips)
Drift ratio (%)


FSC-R 61
FSC-R 62
FSC-R 63
FSC-R 64
FSC-R 65
FSC-R 66
Lateral load (kips)
Drift ratio (%)


FSC-R 67
FSC-R 68
FSC-R 69
FSC-R 70
FSC-R 71
FSC-R 72
Lateral load (kips)
Drift ratio (%)


FSC-R 73
FSC-R 74
FSC-R 75
FSC-R 76
FSC-R 77
FSC-R 78
Lateral load (kips)
Drift ratio (%)

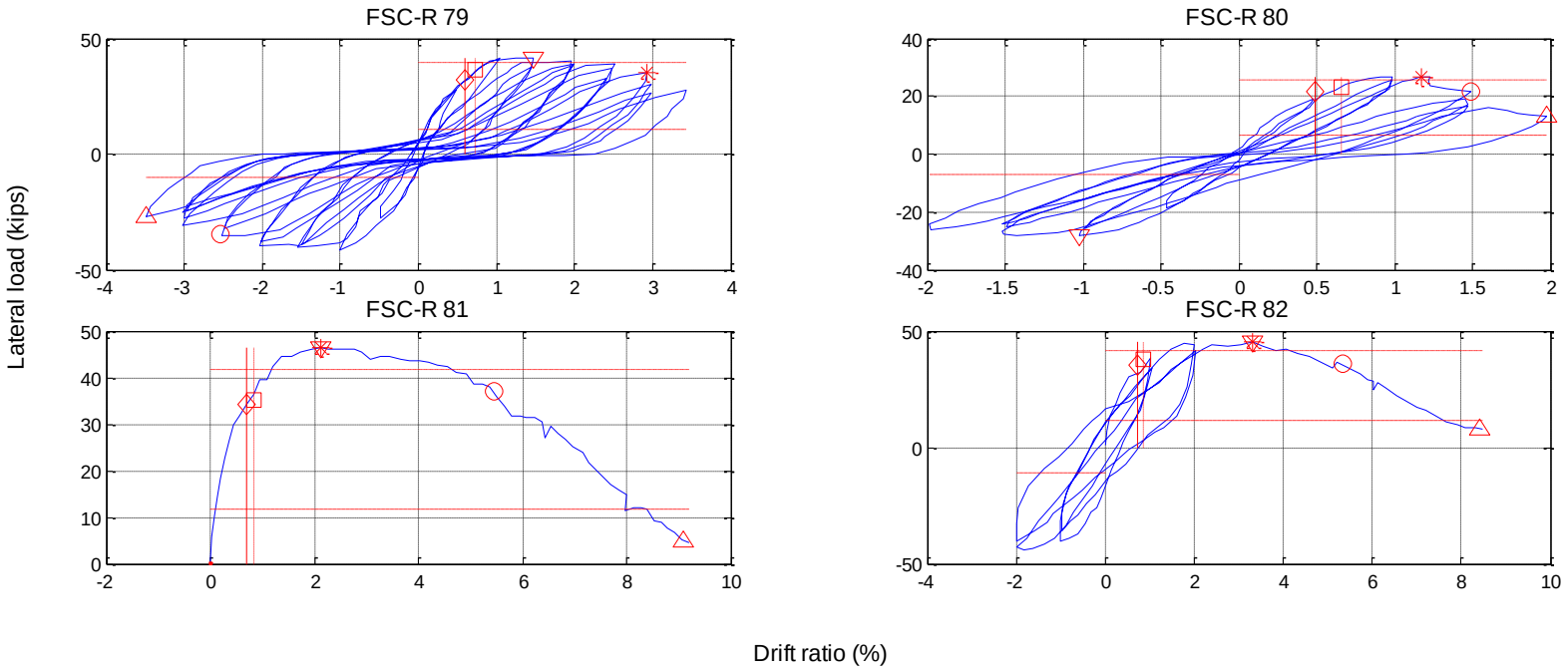
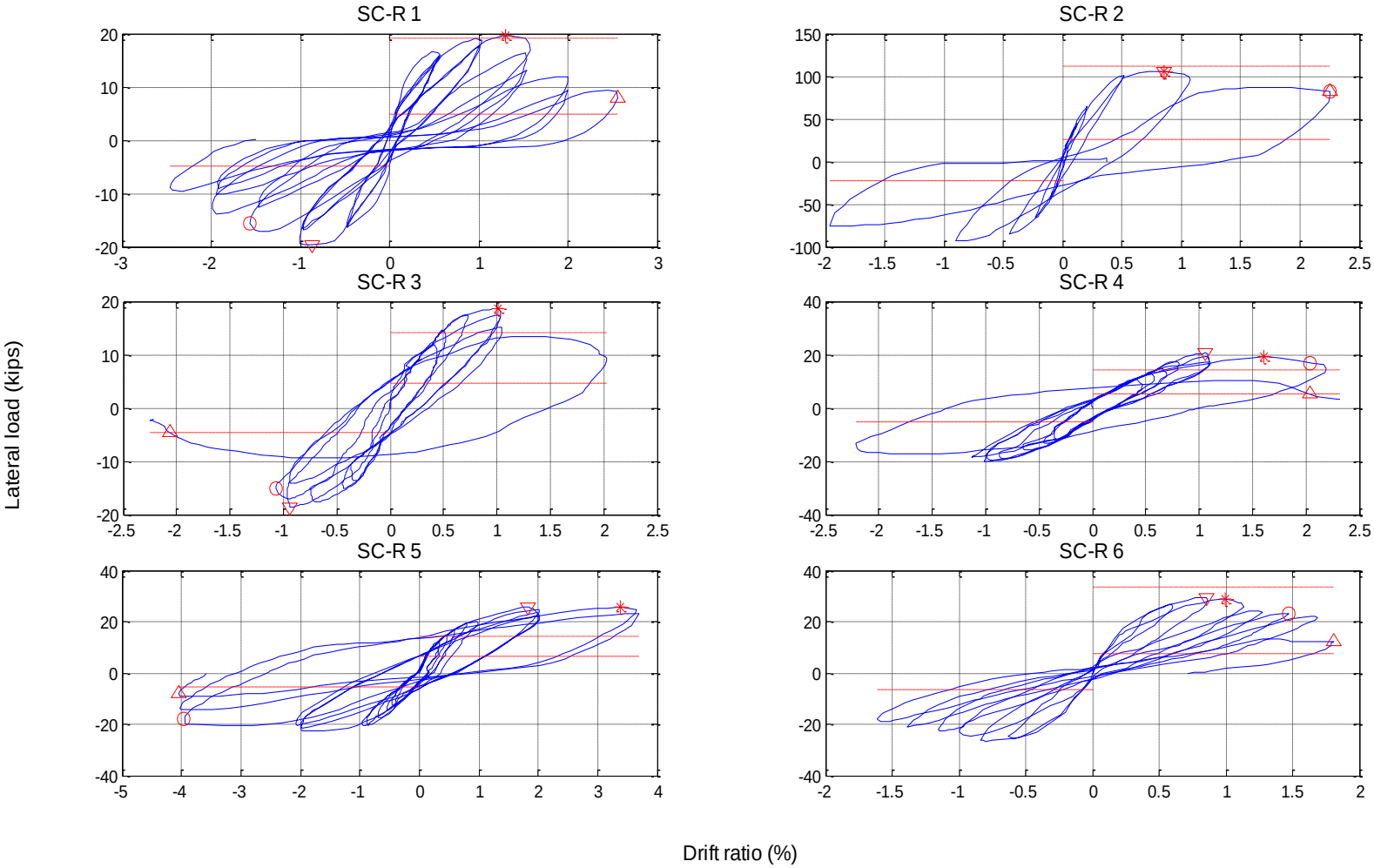
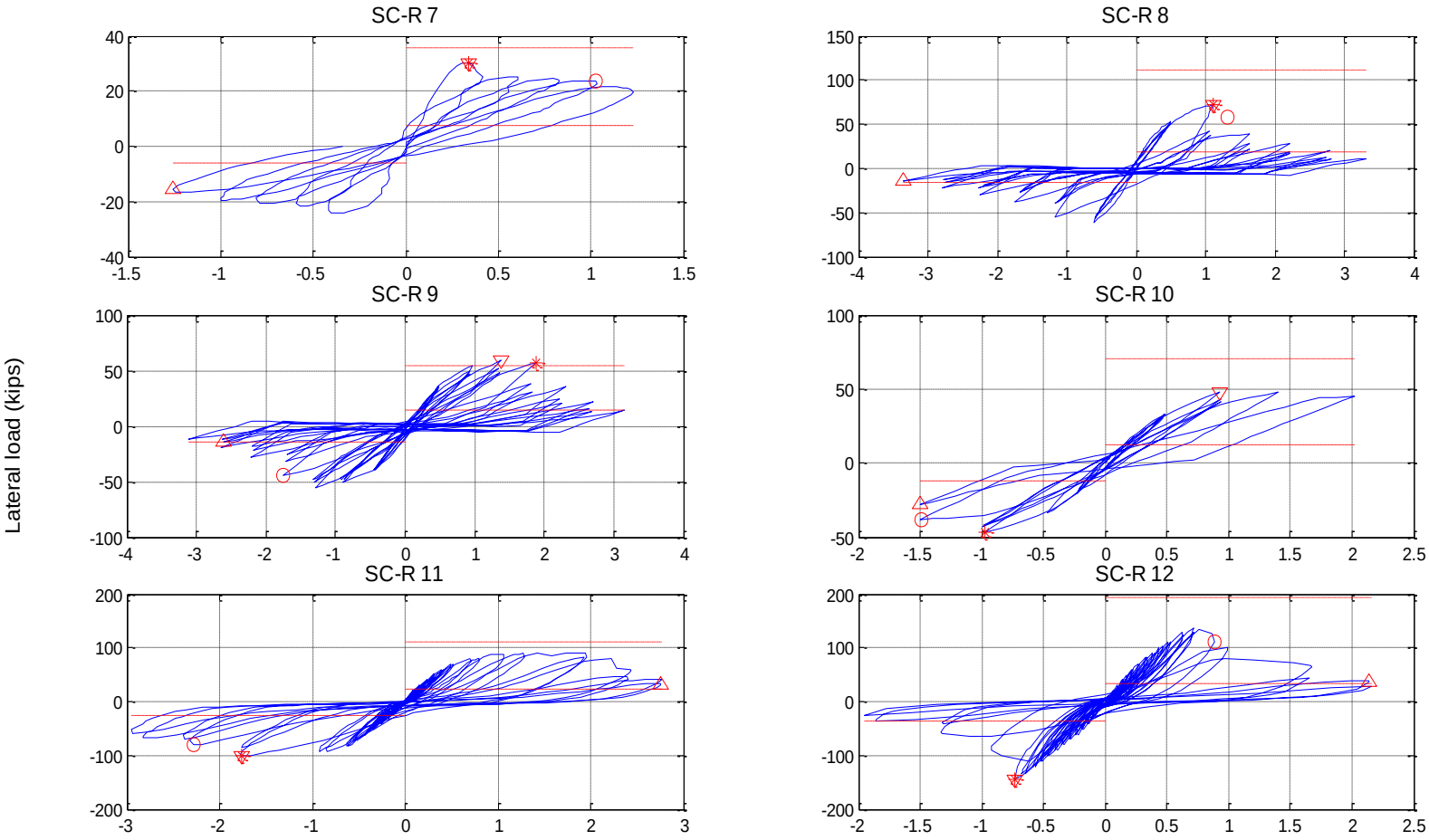
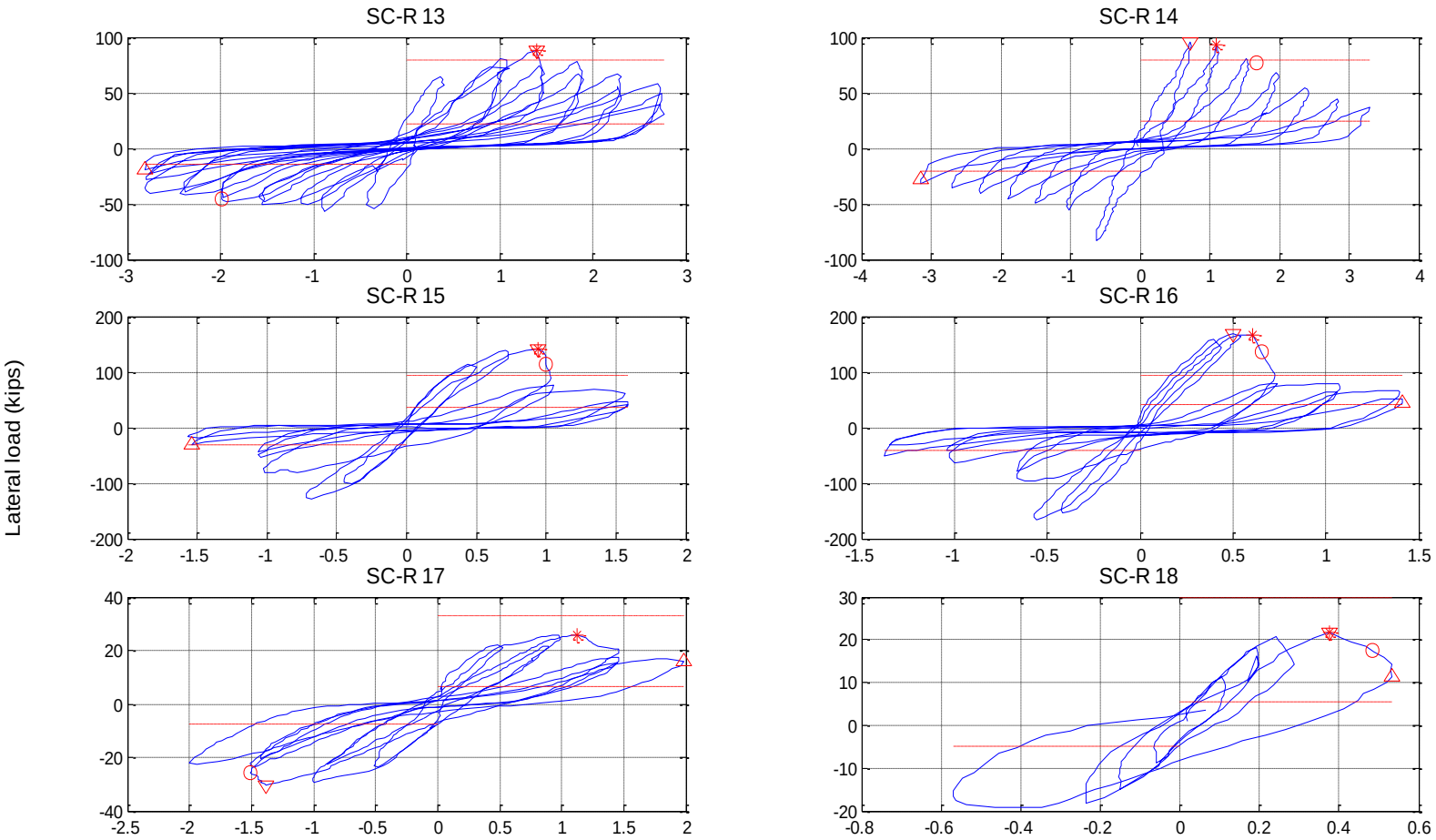
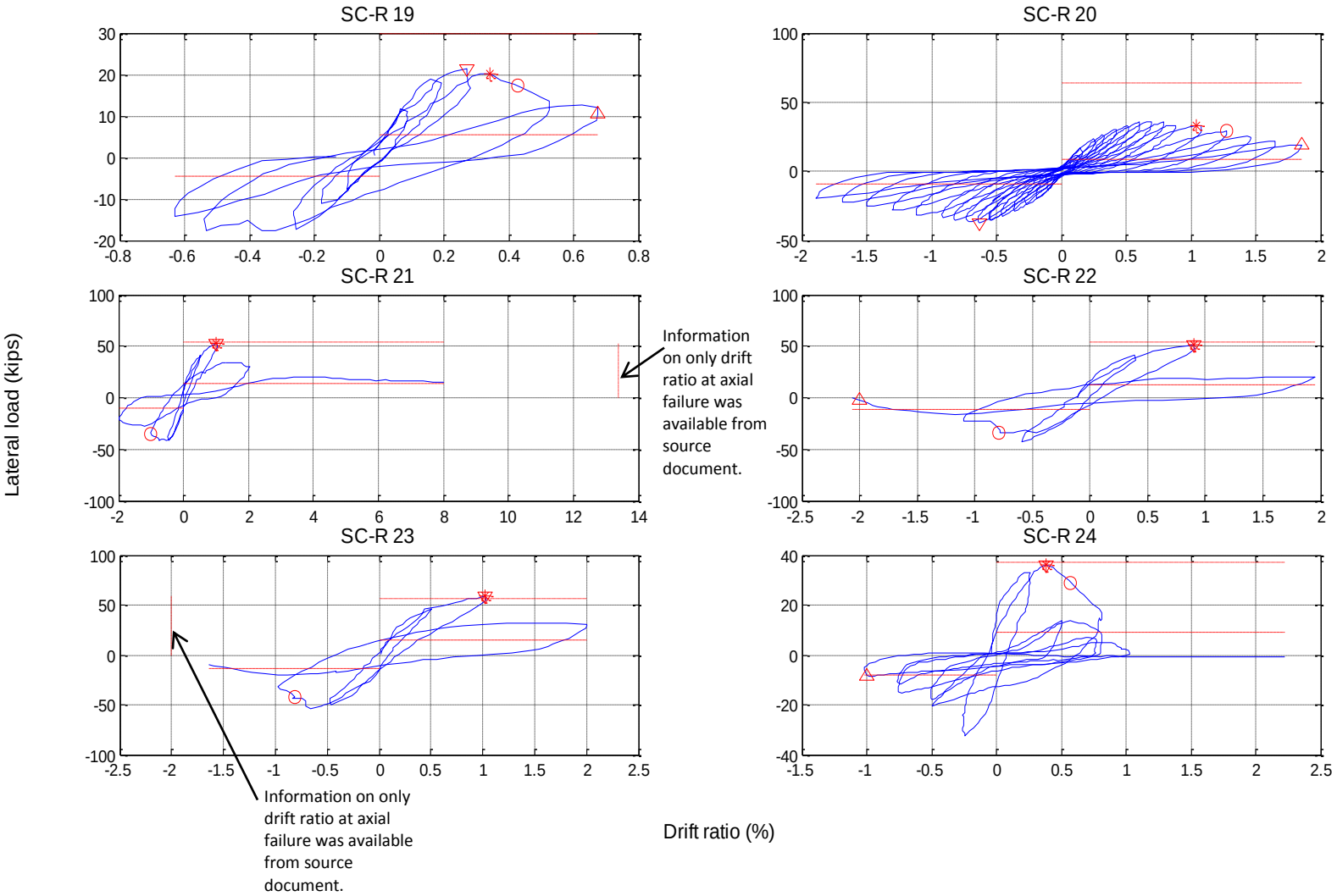

FSC-R 79
FSC-R 80
FSC-R 81
FSC-R 82
Lateral load (kips)
Drift ratio (%)

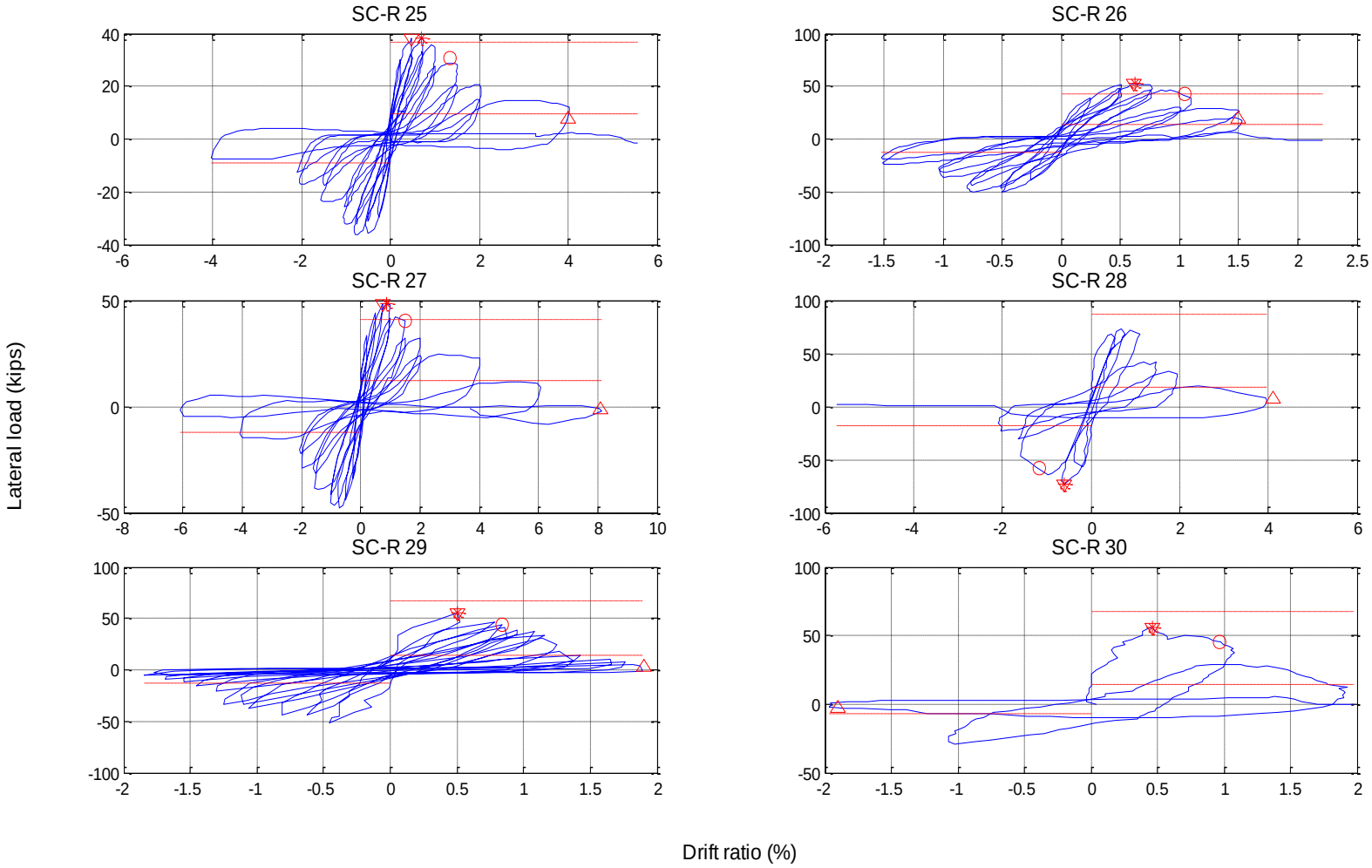
Figure B.3: Force displacement plots of SC-R columns

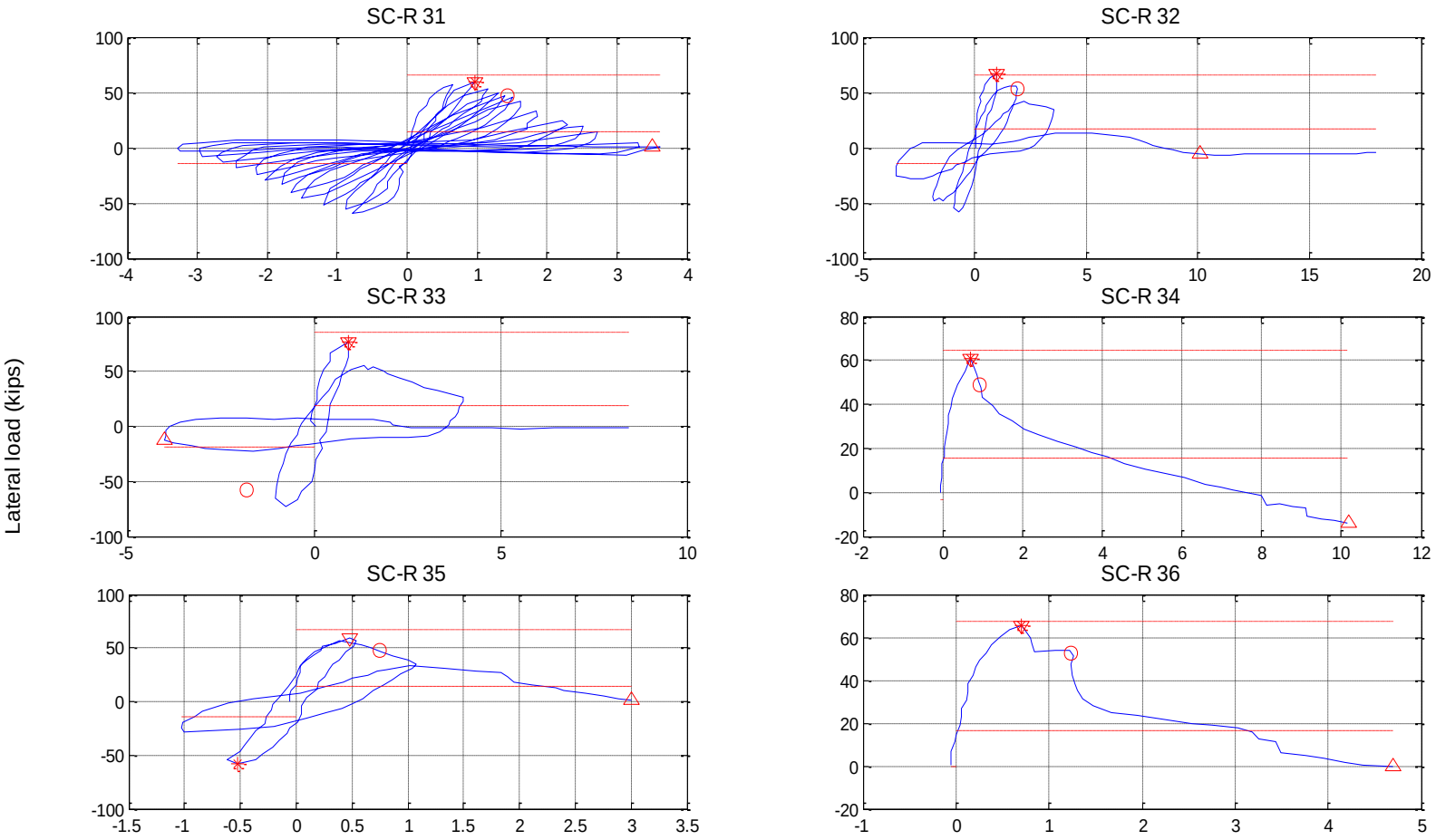



SC-R 7
SC-R 8
SC-R 9
SC-R 10
SC-R 11
SC-R 12
Lateral load (kips)
Drift ratio (%)


SC-R 13
SC-R 14
SC-R 15
SC-R 16
SC-R 17
SC-R 18
Lateral load (kips)
Drift ratio (%)


SC-R 19
SC-R 20
SC-R 21
SC-R 22
SC-R 23
SC-R 24
Lateral load (kips)
Drift ratio (%)
Information on only drift ratio at axial failure was available from source document.
Information on only drift ratio at axial failure was available from source document.


SC-R 25
SC-R 26
SC-R 27
SC-R 28
SC-R 29
SC-R 30
Lateral load (kips)
Drift ratio (%)


SC-R 31
SC-R 32
SC-R 33
SC-R 34
SC-R 35
SC-R 36
Lateral load (kips)
Drift ratio (%)

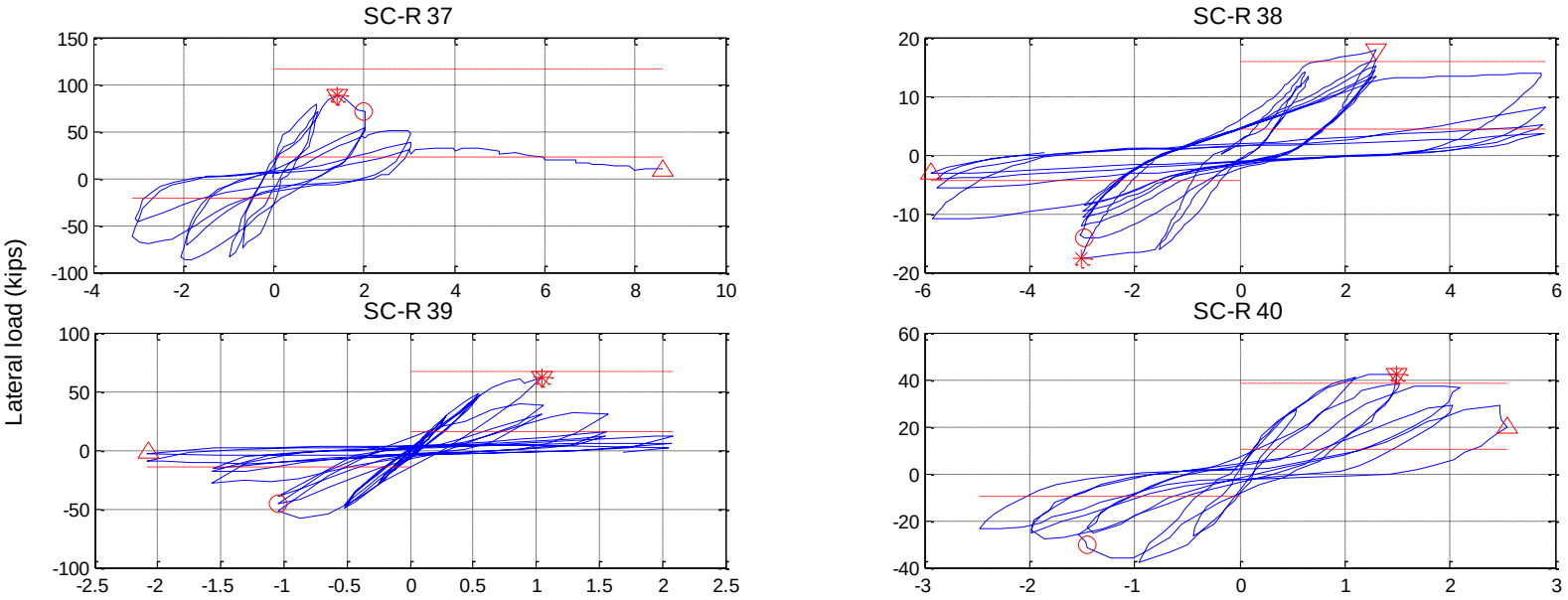
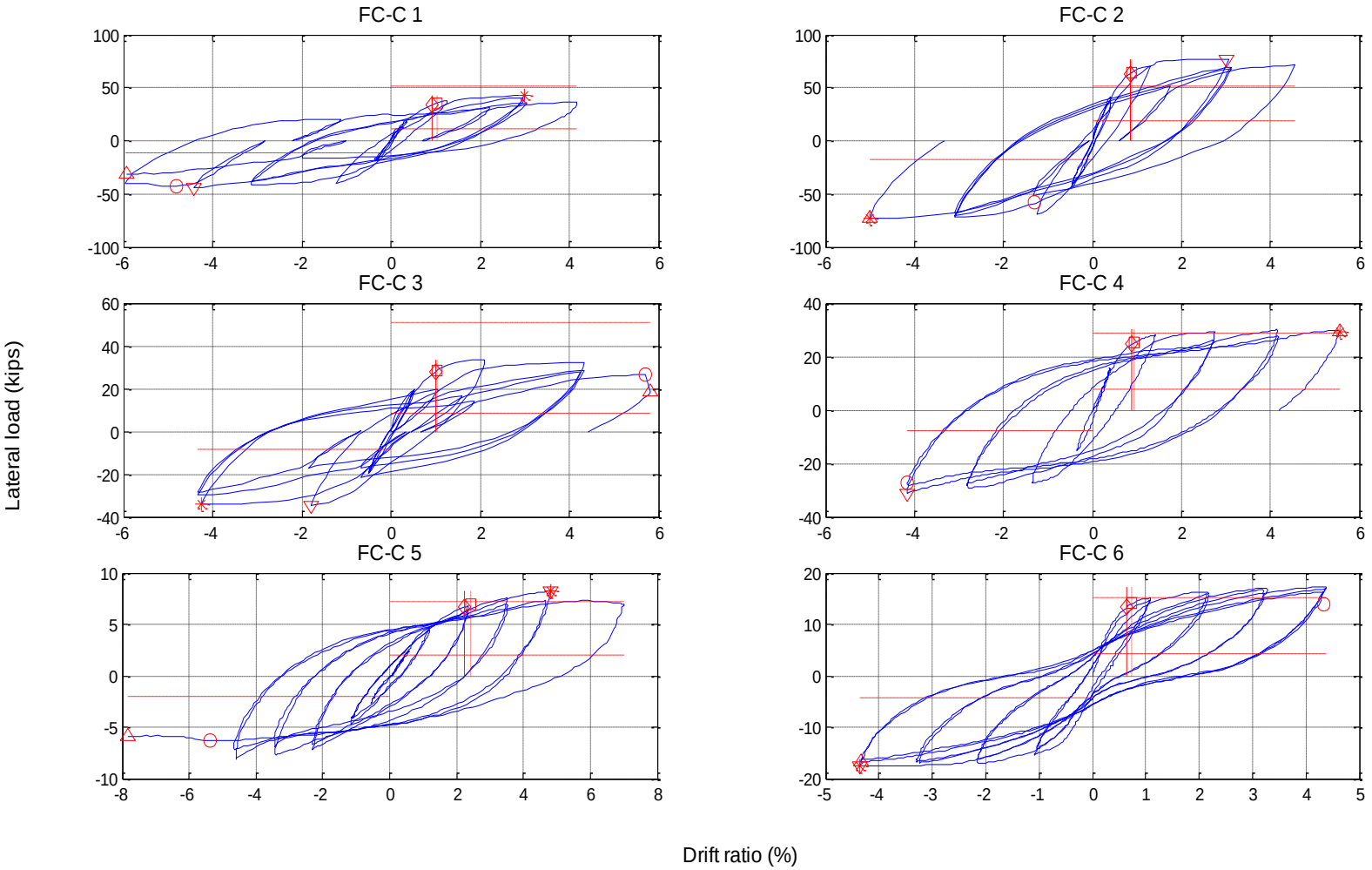
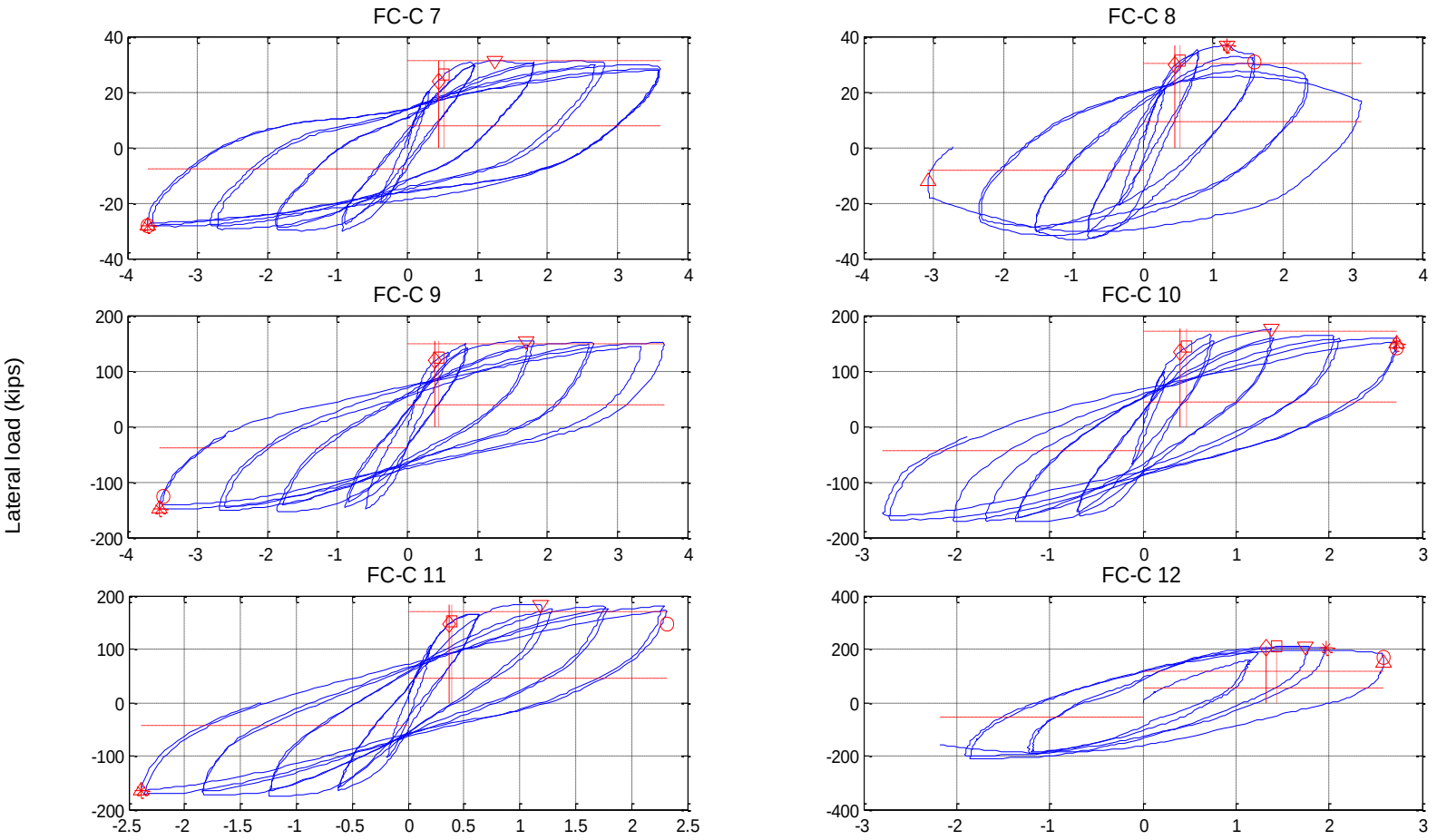
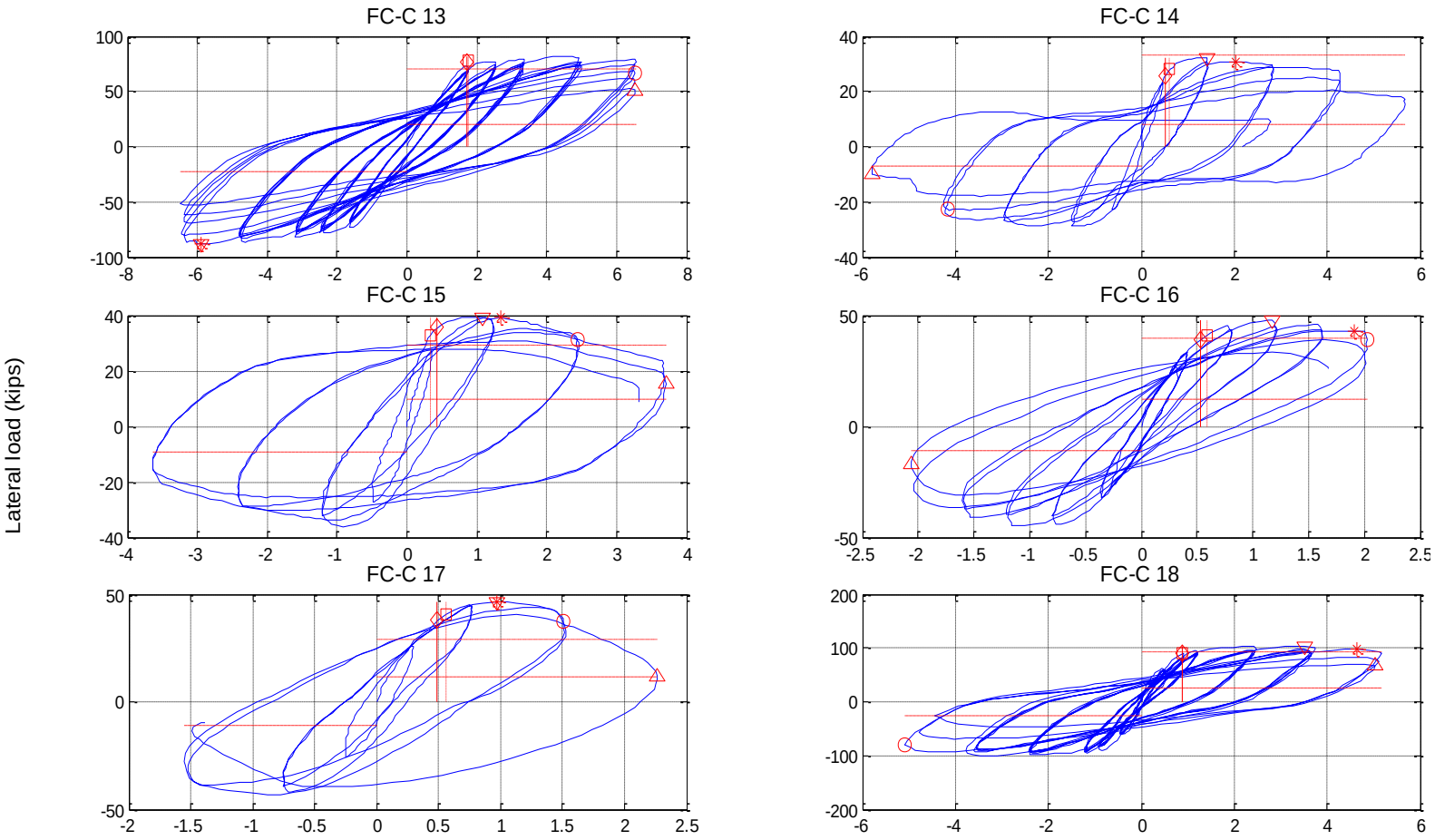
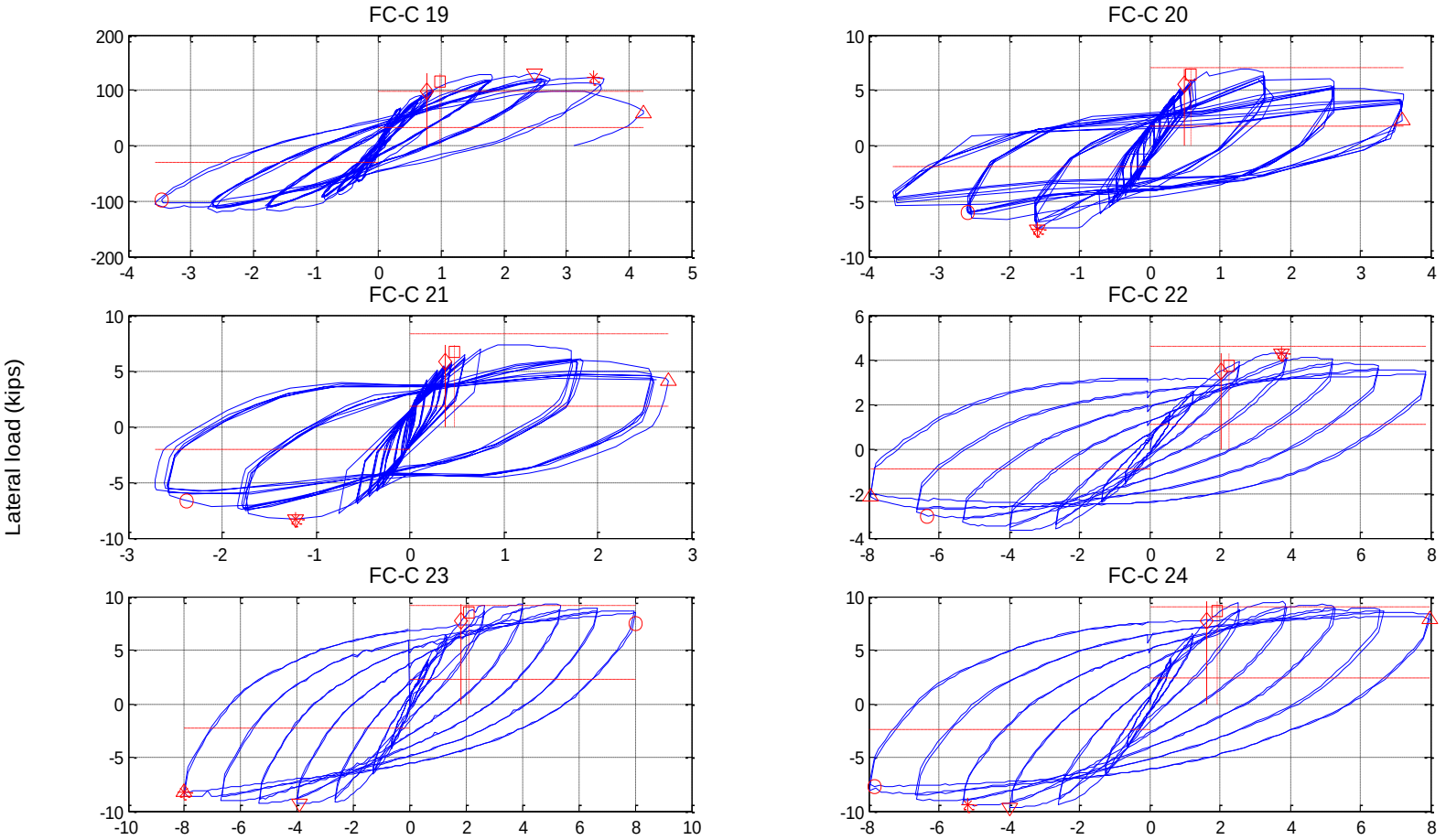

SC-R 37
SC-R 38
SC-R 39
SC-R 40
Lateral load (kips)
Drift ratio (%)

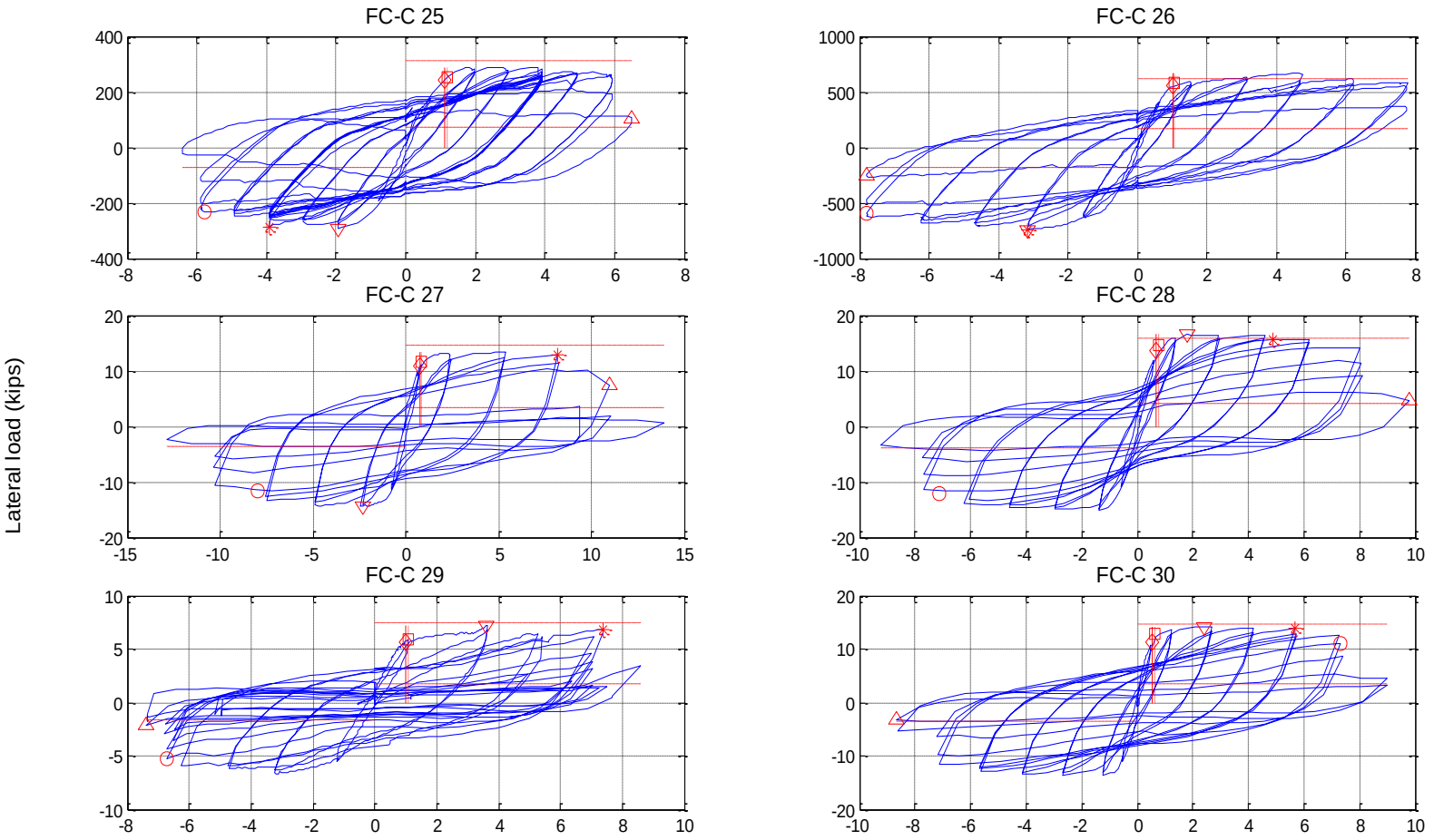
Figure B.4: Force-displacement plots of FC-C columns

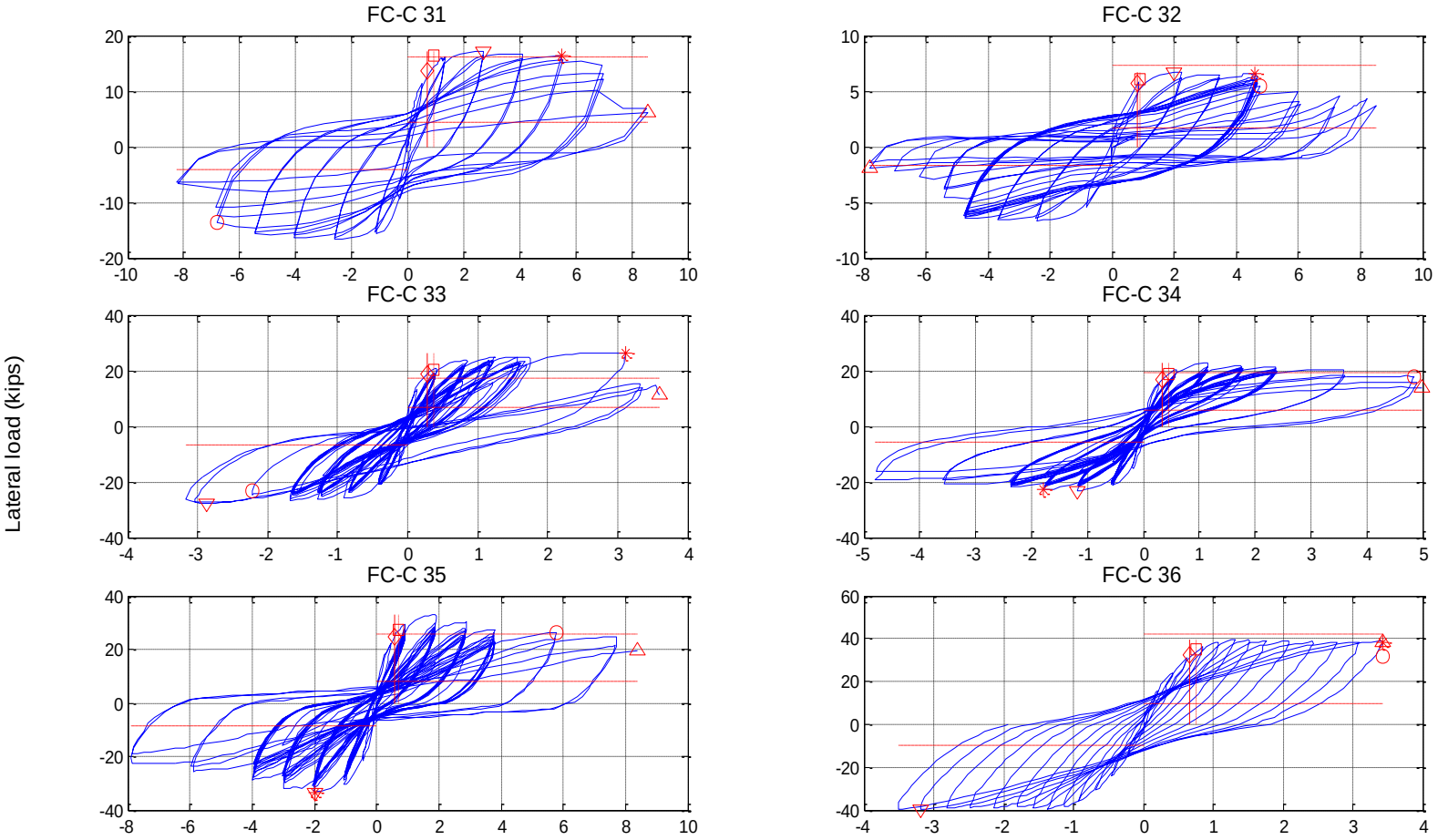


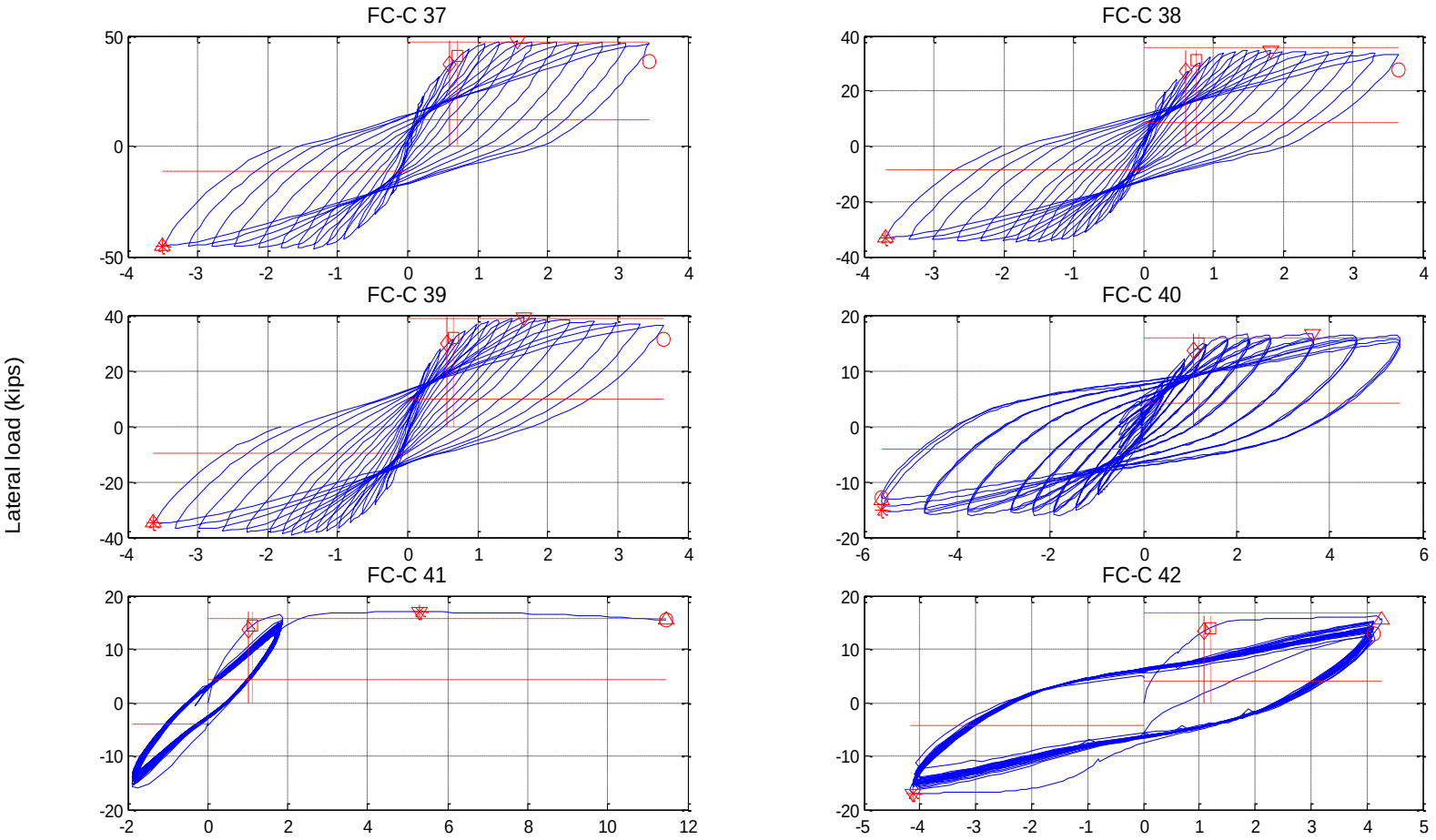

FC-C 7
FC-C 8
FC-C 9
FC-C 10
FC-C 11
FC-C 12
Lateral load (kips)
Drift ratio (%)

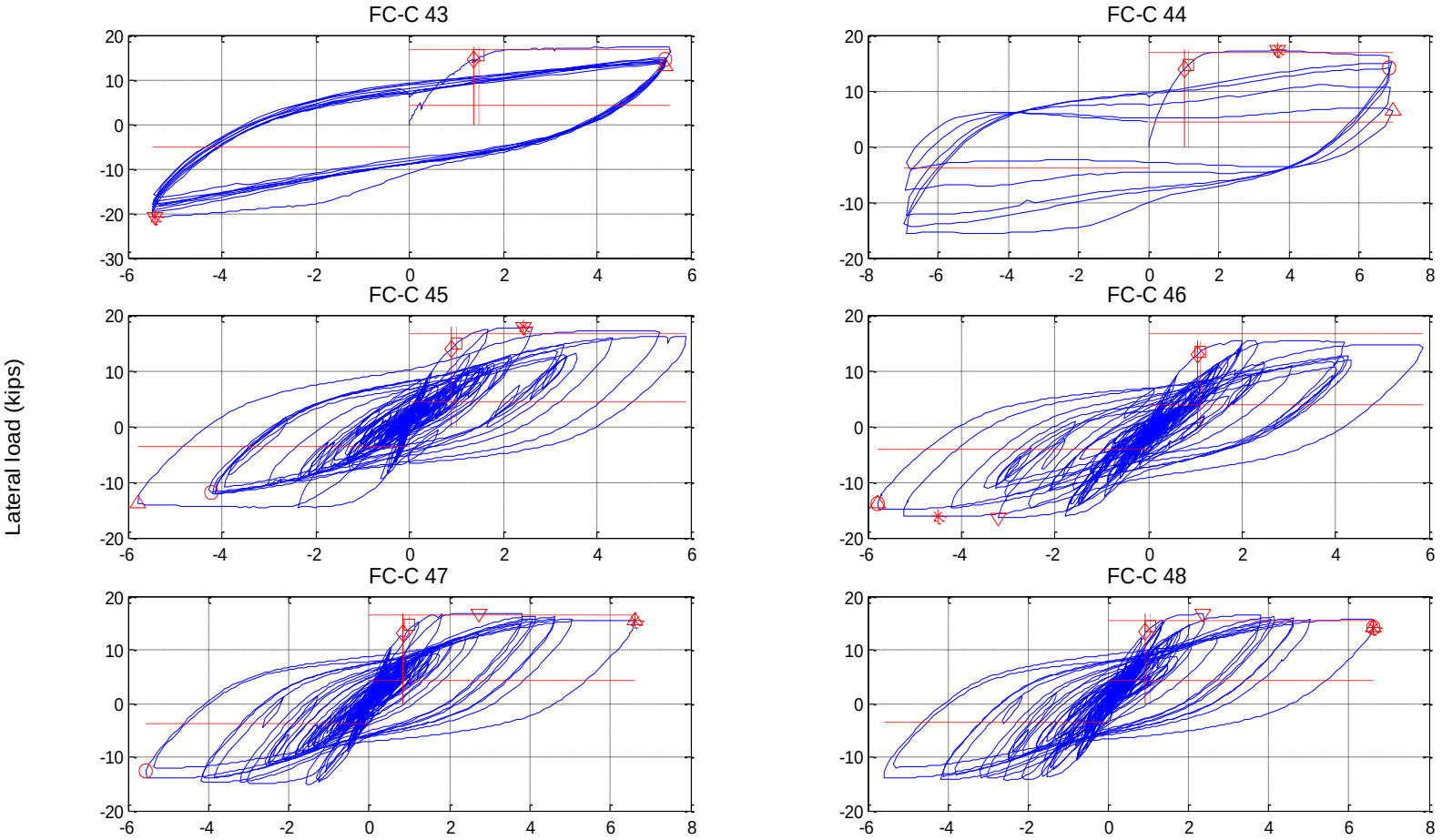

FC-C 13
FC-C 14
FC-C 15
FC-C 16
FC-C 17
FC-C 18
Lateral load (kips)
Drift ratio (%)

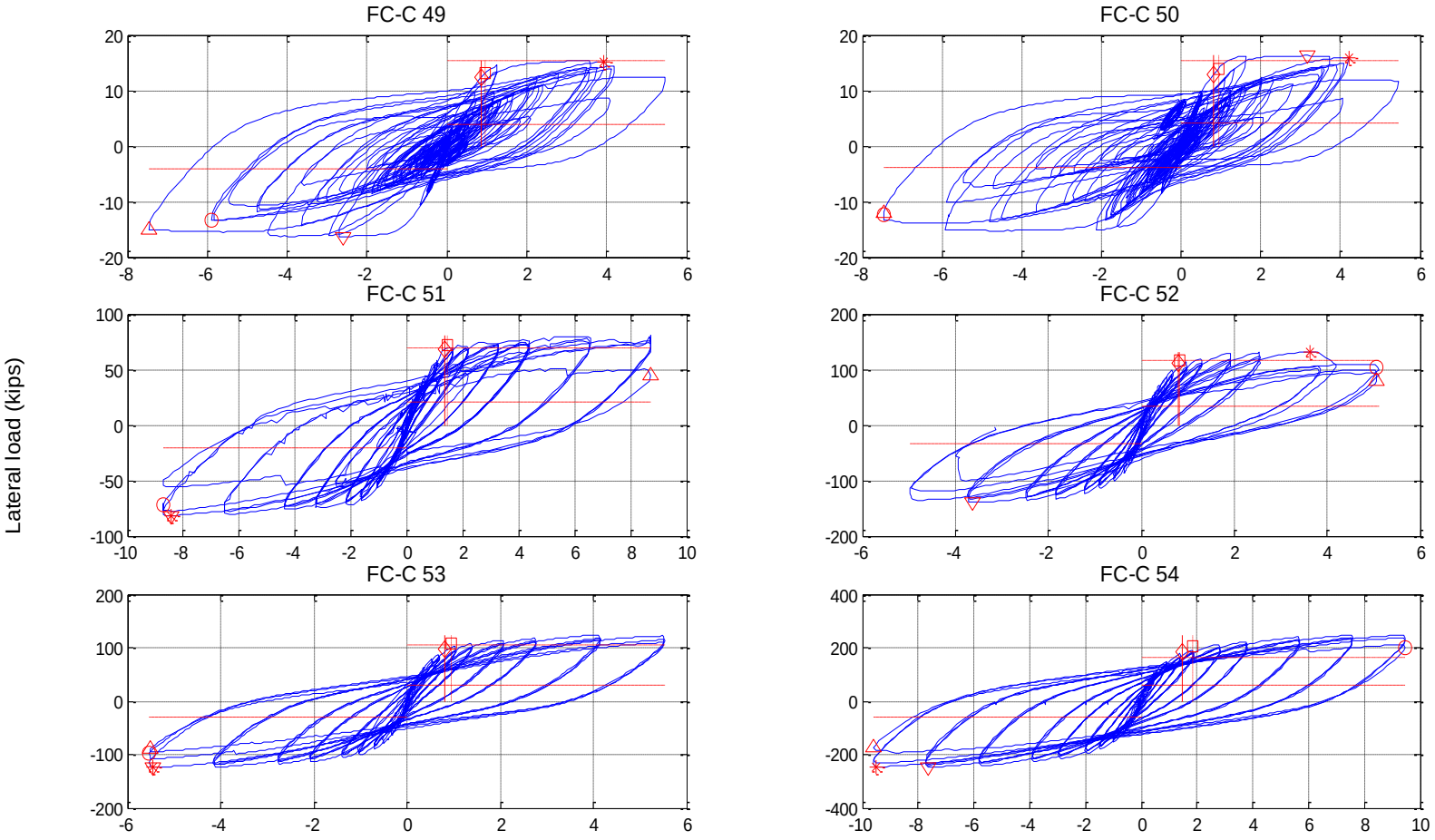

FC-C 19
FC-C 20
FC-C 21
FC-C 22
FC-C 23
FC-C 24
Lateral load (kips)
Drift ratio (%)

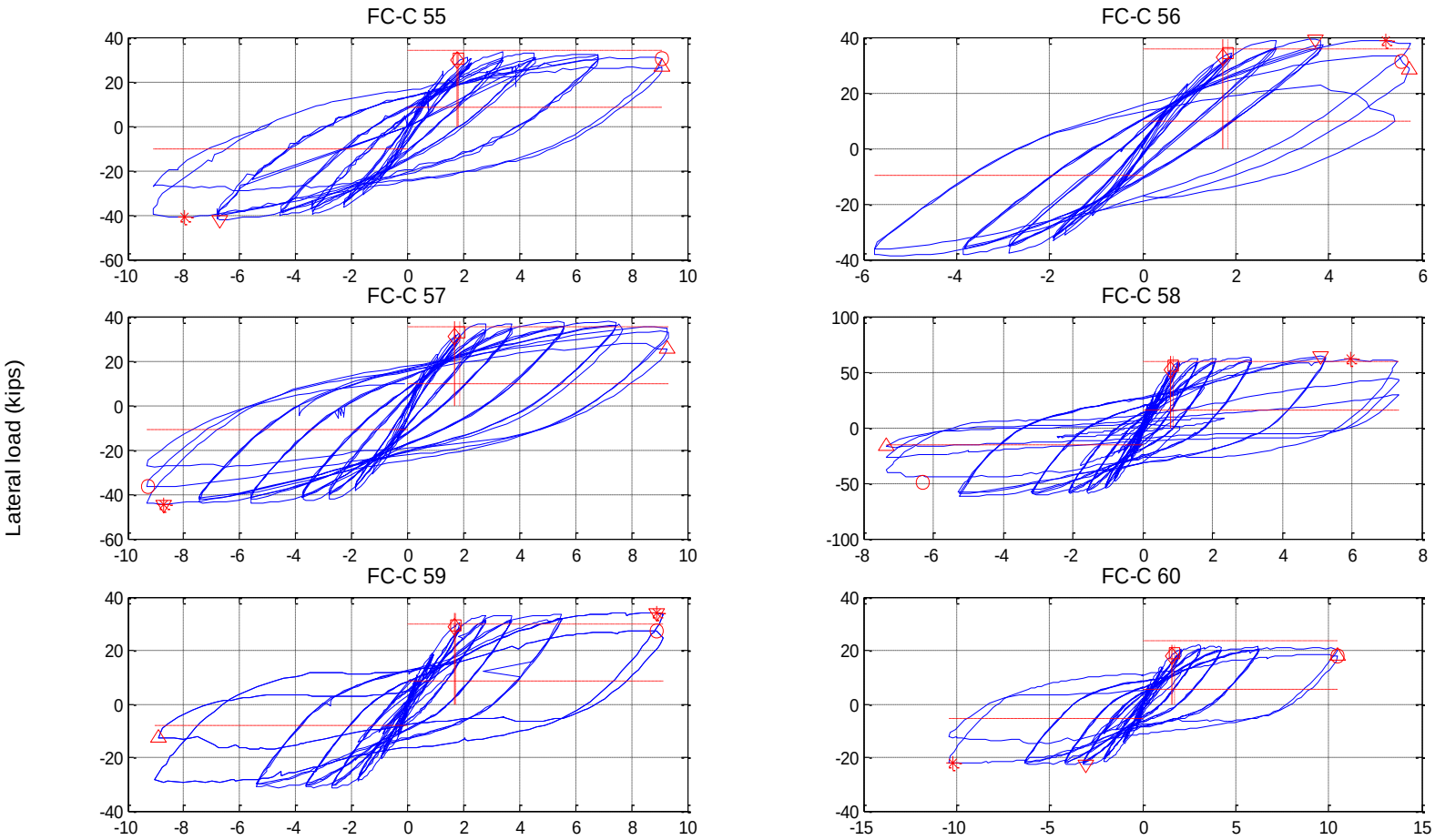

FC-C 25
FC-C 26
FC-C 27
FC-C 28
FC-C 29
FC-C 30
Lateral load (kips)
Drift ratio (%)

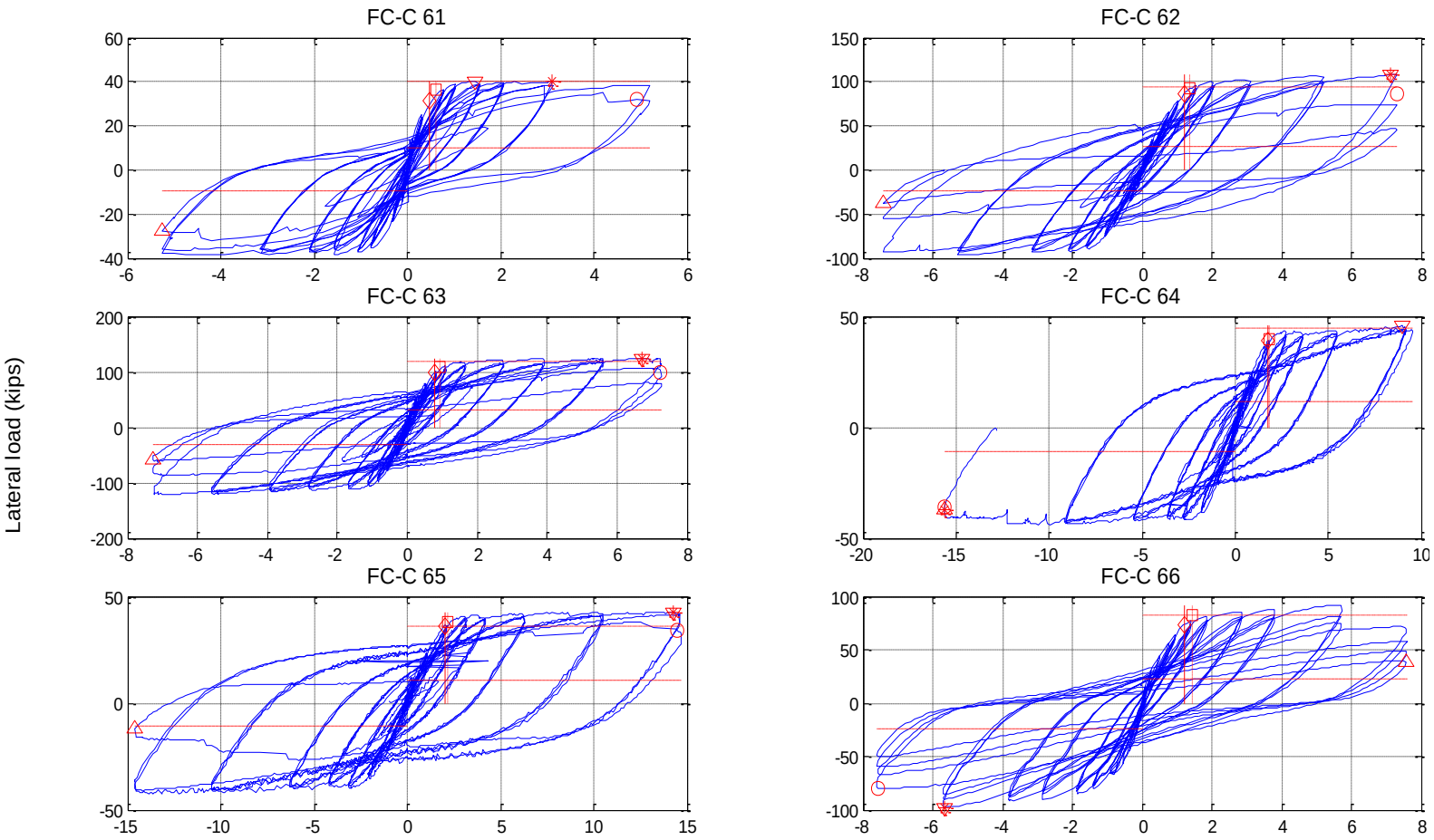

FC-C 31
FC-C 32
FC-C 33
FC-C 34
FC-C 35
FC-C 36
Lateral load (kips)
Drift ratio (%)

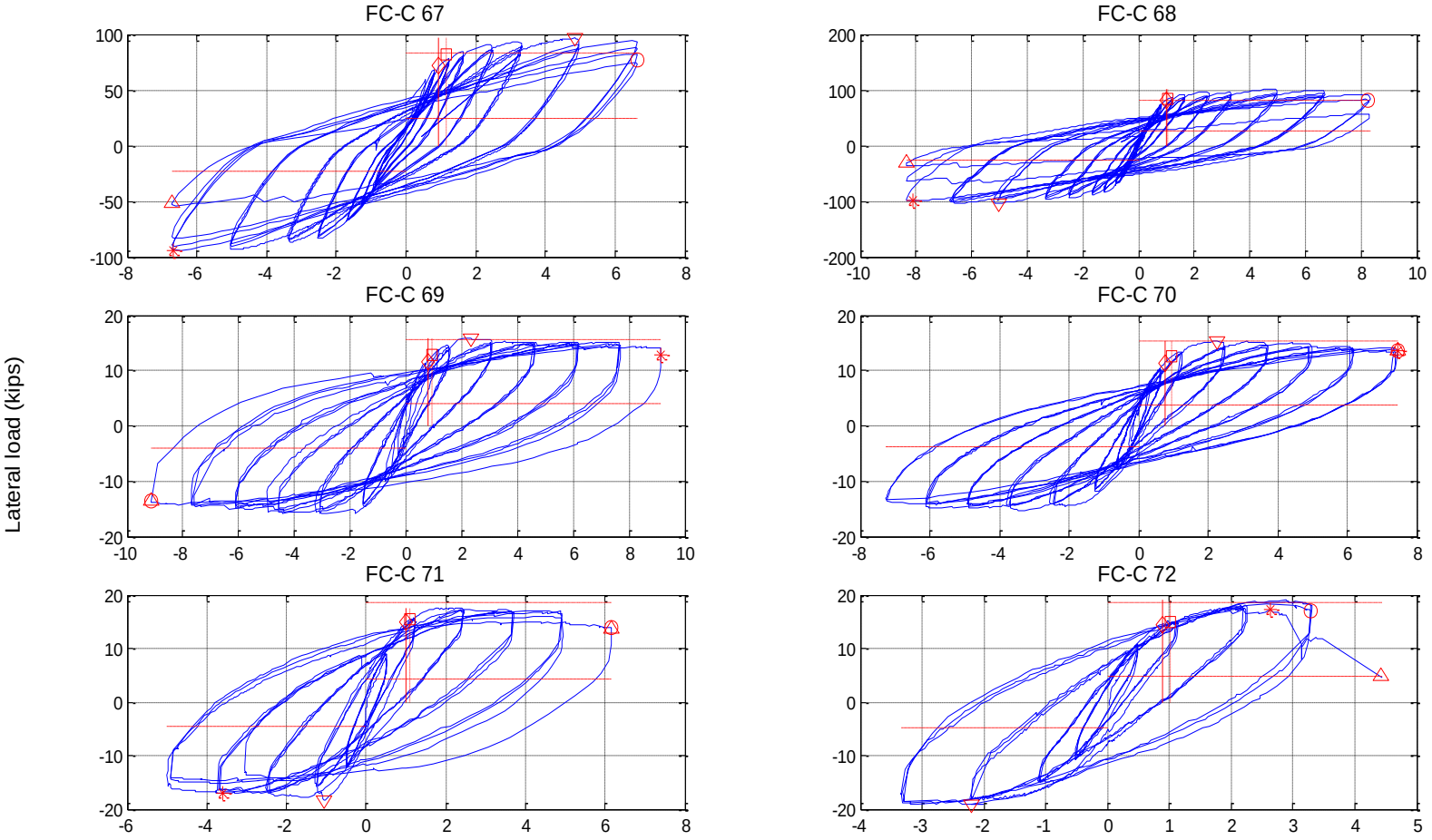

FC-C 37
FC-C 38
FC-C 39
FC-C 40
FC-C 41
FC-C 42
Lateral load (kips)
Drift ratio (%)

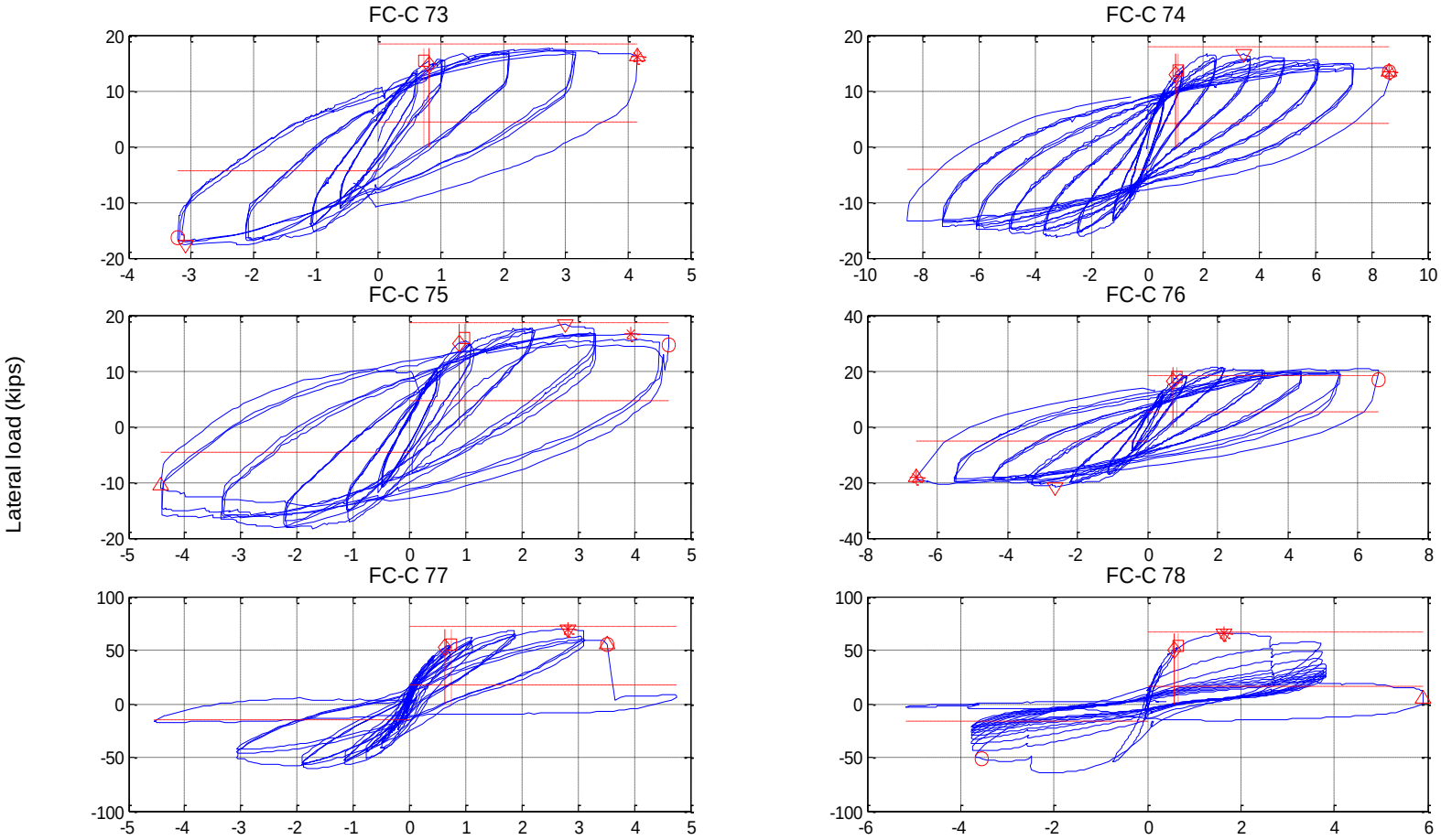

FC-C 43
FC-C 44
FC-C 45
FC-C 46
FC-C 47
FC-C 48
Lateral load (kips)
Drift ratio (%)

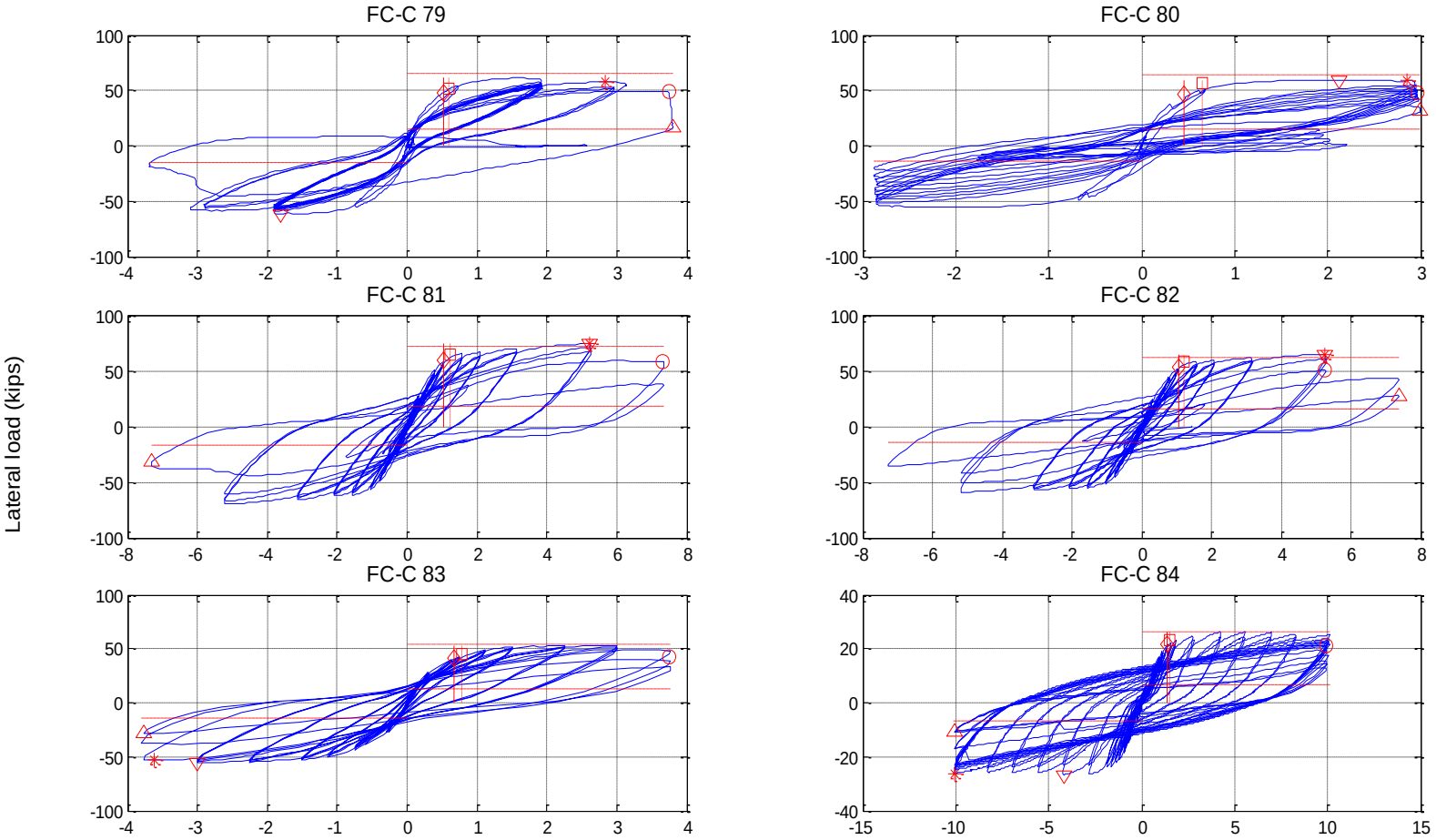

FC-C 49
FC-C 50
FC-C 51
FC-C 52
FC-C 53
FC-C 54
Lateral load (kips)
Drift ratio (%)

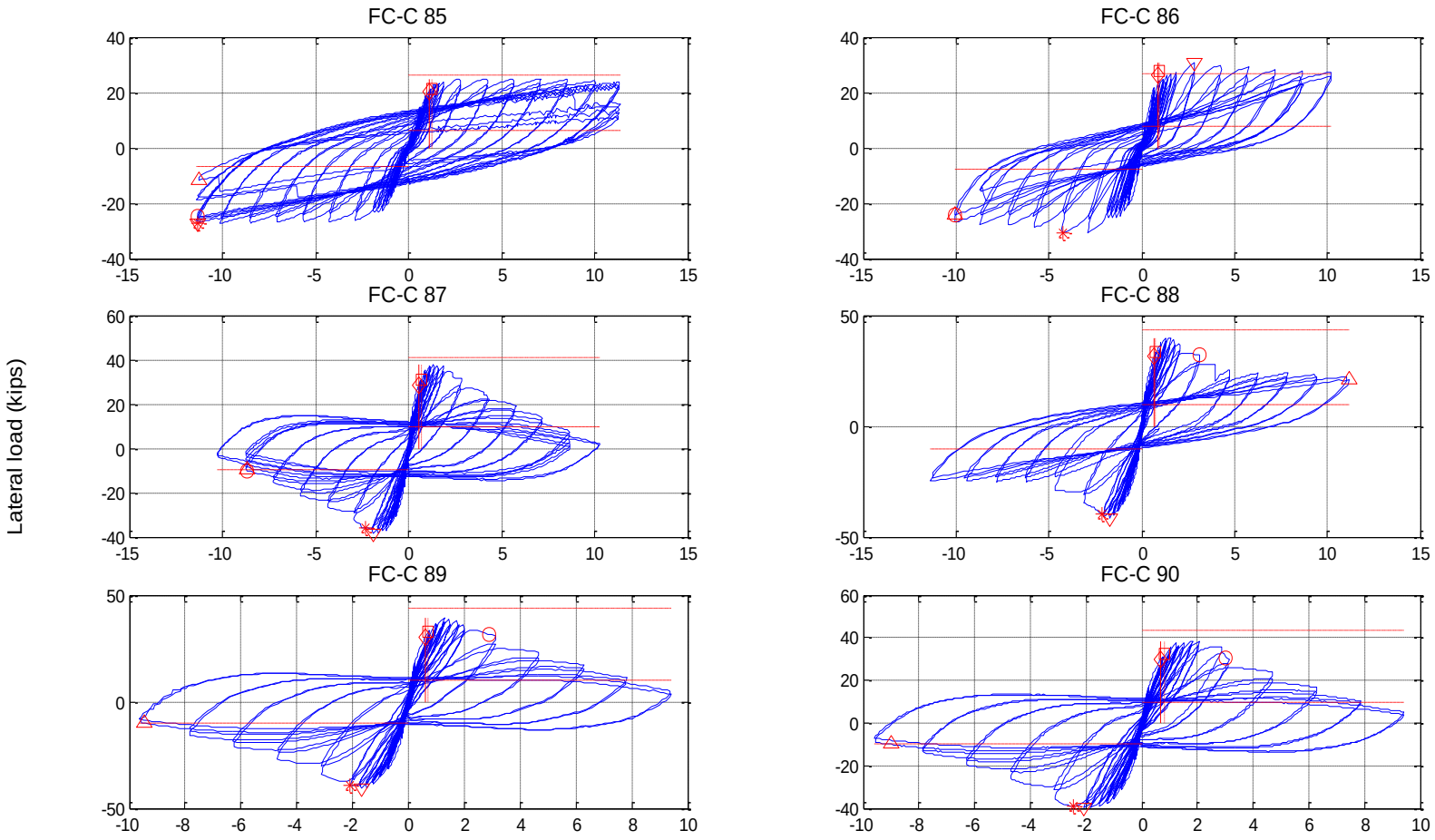

FC-C 55
FC-C 56
FC-C 57
FC-C 58
FC-C 59
FC-C 60
Lateral load (kips)
Drift ratio (%)

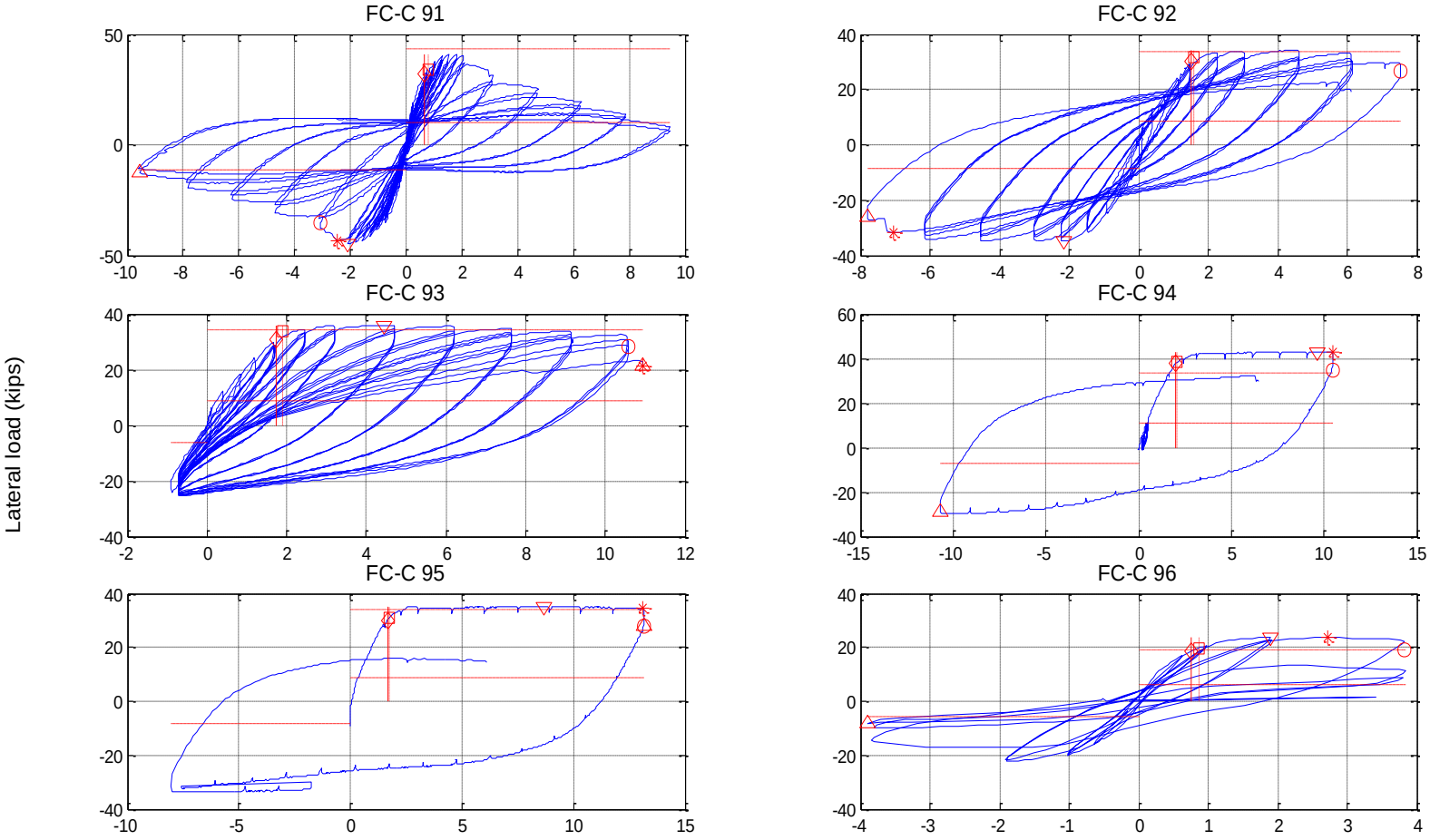

FC-C 61
FC-C 62
FC-C 63
FC-C 64
FC-C 65
FC-C 66
Lateral load (kips)
Drift ratio (%)


FC-C 67
FC-C 68
FC-C 69
FC-C 70
FC-C 71
FC-C 72
Lateral load (kips)
Drift ratio (%)


FC-C 73
FC-C 74
FC-C 75
FC-C 76
FC-C 77
FC-C 78
Lateral load (kips)
Drift ratio (%)


FC-C 79
FC-C 80
FC-C 81
FC-C 82
FC-C 83
FC-C 84
Lateral load (kips)
Drift ratio (%)


FC-C 85
FC-C 86
FC-C 87
FC-C 88
FC-C 89
FC-C 90
Lateral load (kips)
Drift ratio (%)


FC-C 91
FC-C 92
FC-C 93
FC-C 94
FC-C 95
FC-C 96
Lateral load (kips)
Drift ratio (%)

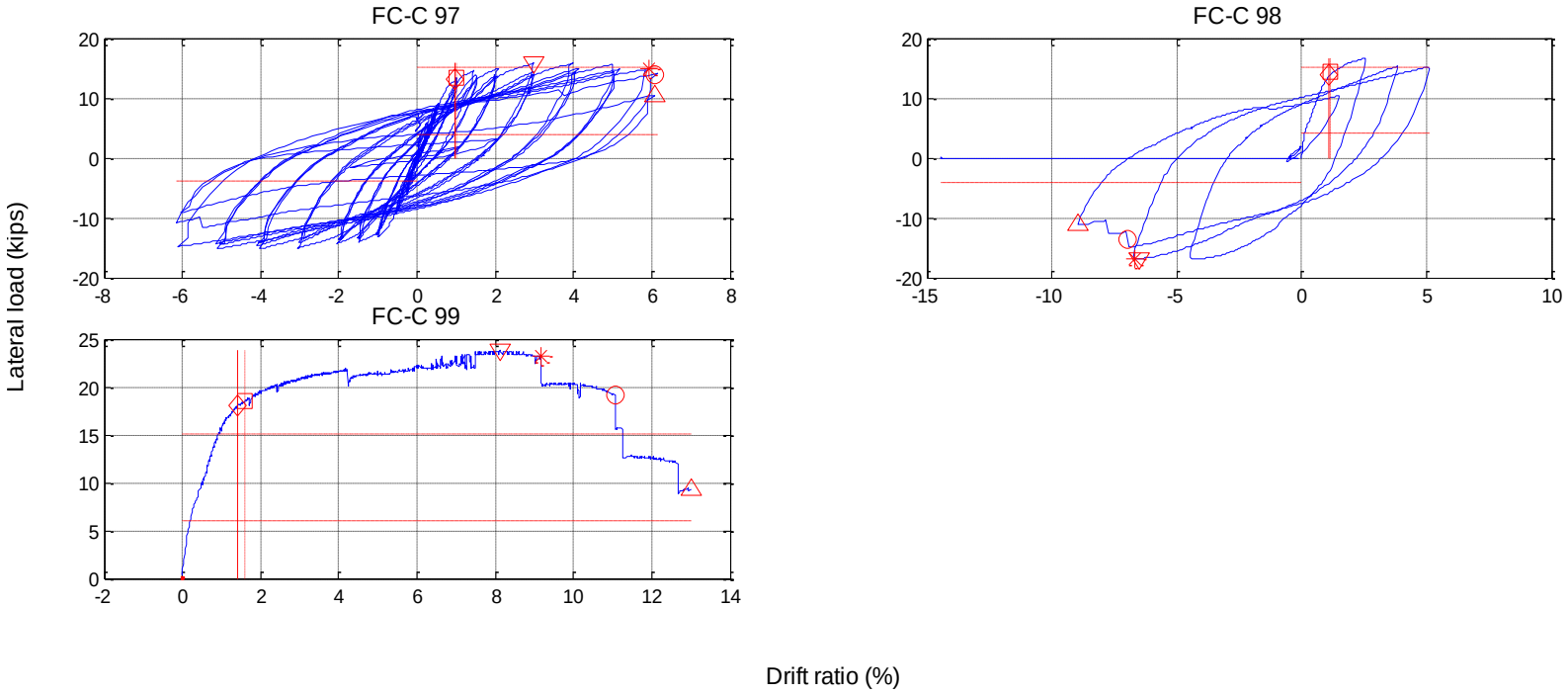
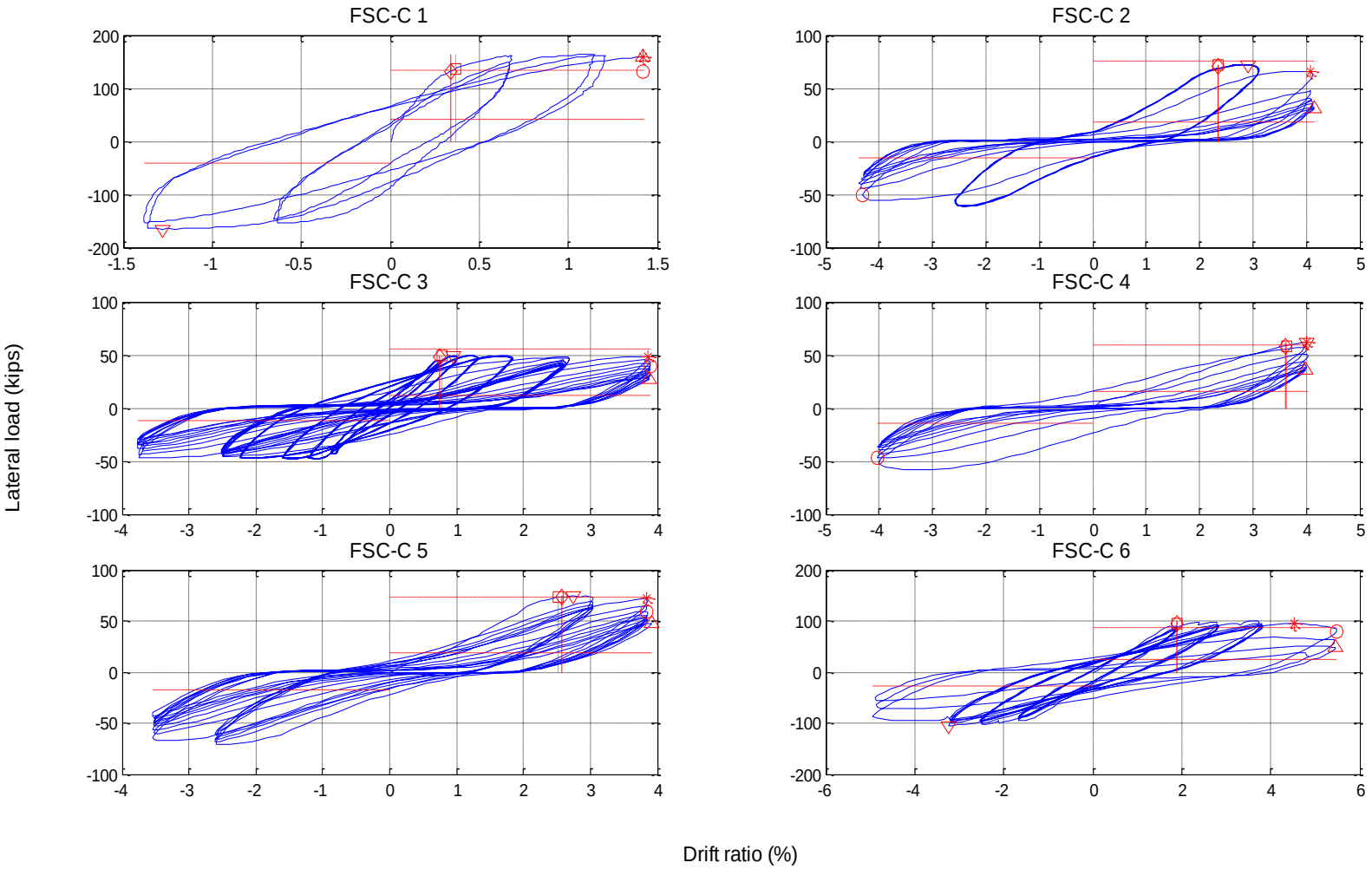
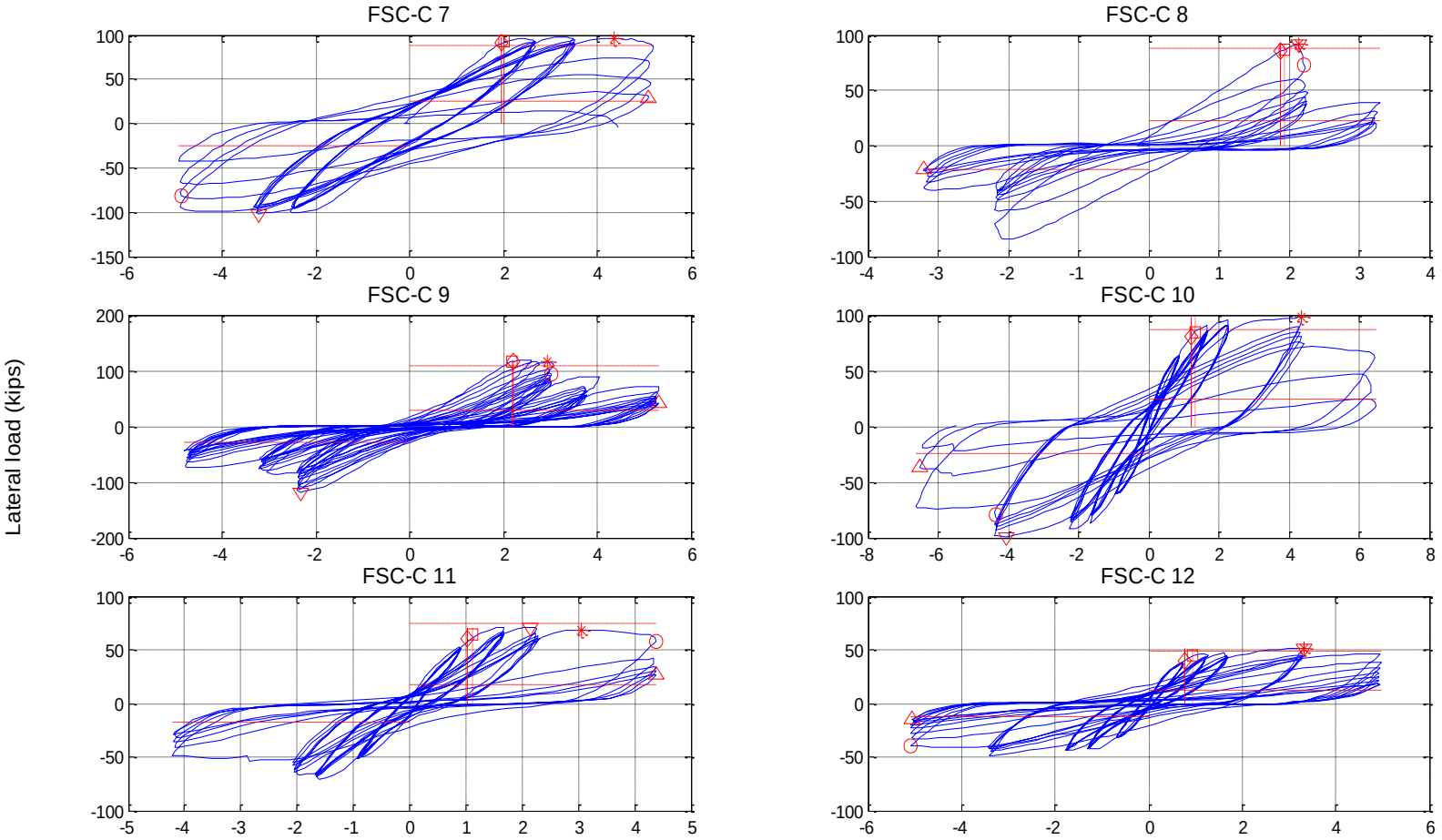
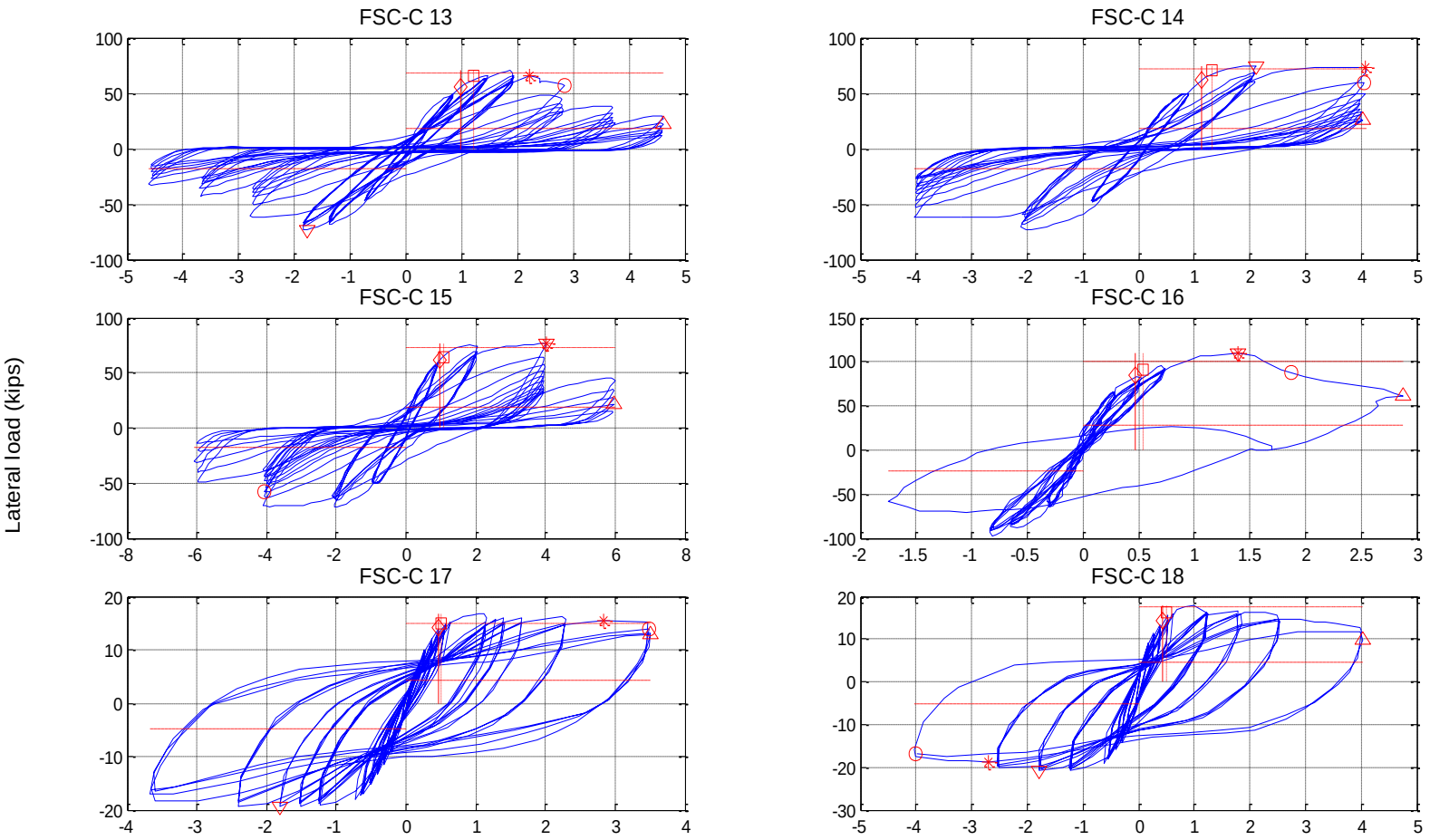
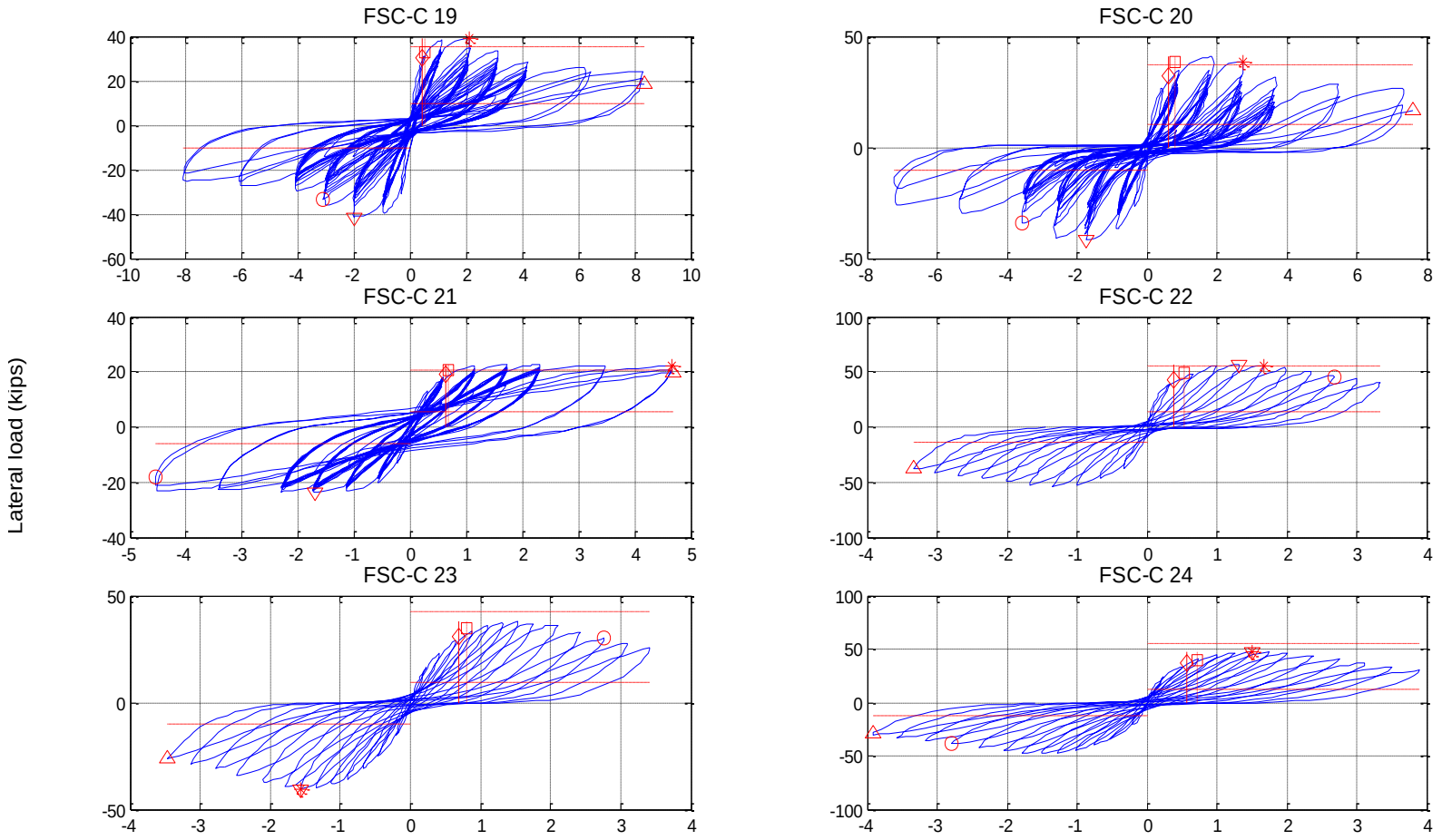

FC-C 97
FC-C 98
FC-C 99
Lateral load (kips)
Drift ratio (%)

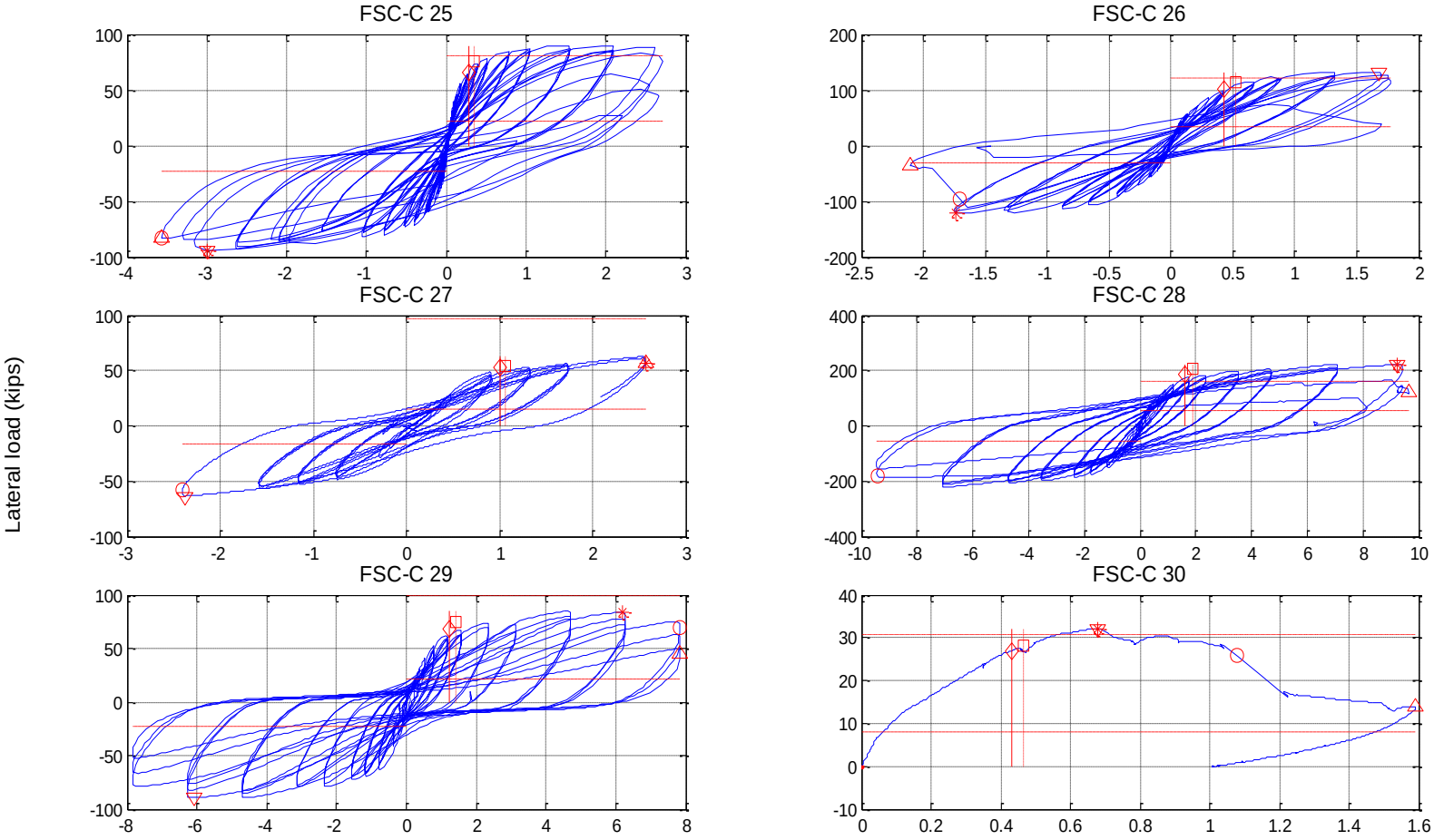
Figure B.5: Force-displacement plots of FSC-C columns

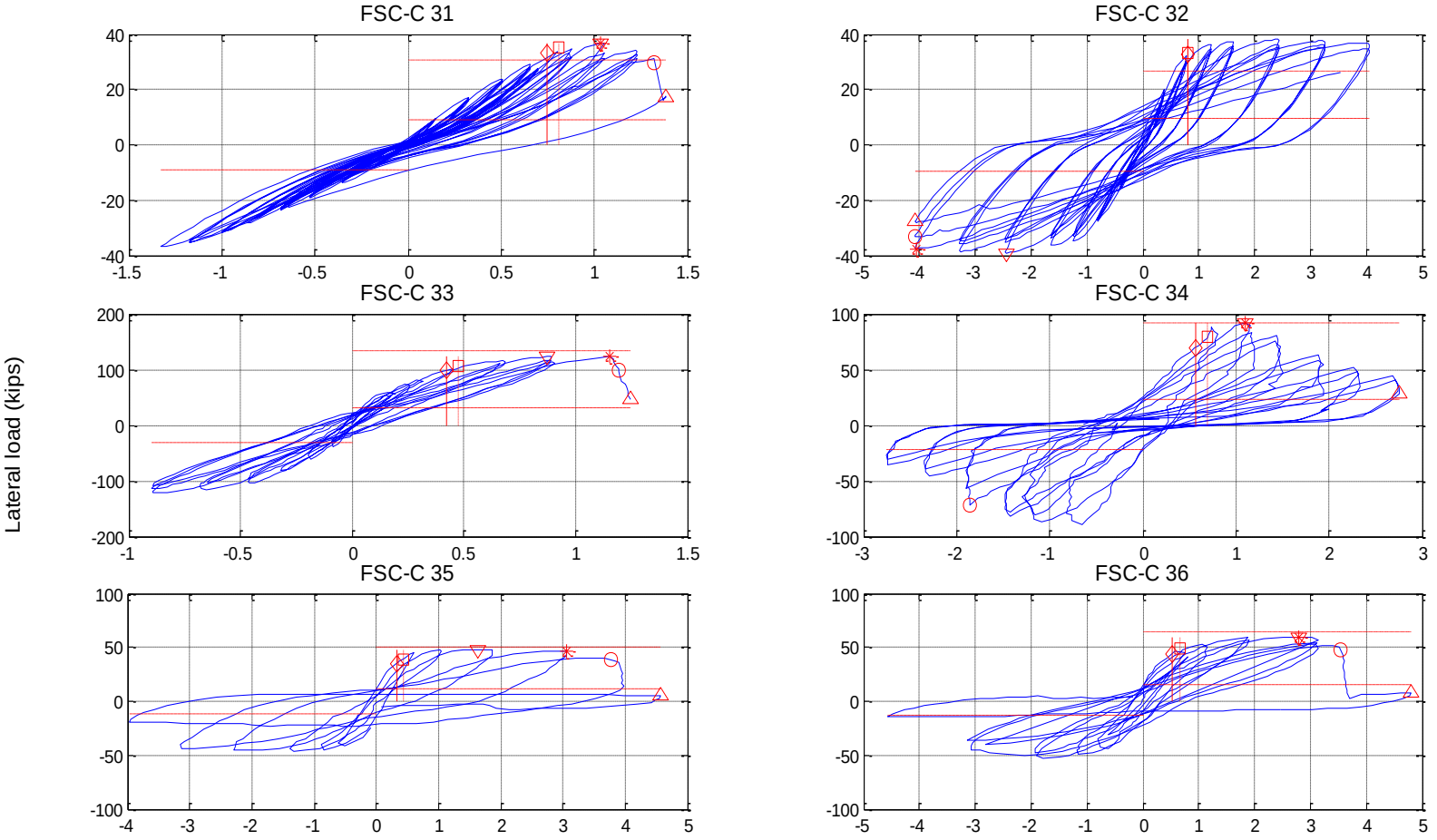



FSC-C 7
FSC-C 8
FSC-C 9
FSC-C 10
FSC-C 11
FSC-C 12
Lateral load (kips)
Drift ratio (%)


FSC-C 13
FSC-C 14
FSC-C 15
FSC-C 16
FSC-C 17
FSC-C 18
Lateral load (kips)
Drift ratio (%)


FSC-C 19
FSC-C 20
FSC-C 21
FSC-C 22
FSC-C 23
FSC-C 24
Lateral load (kips)
Drift ratio (%)


FSC-C 25
FSC-C 26
FSC-C 27
FSC-C 28
FSC-C 29
FSC-C 30
Lateral load (kips)
Drift ratio (%)


FSC-C 31
FSC-C 32
FSC-C 33
FSC-C 34
FSC-C 35
FSC-C 36
Lateral load (kips)
Drift ratio (%)

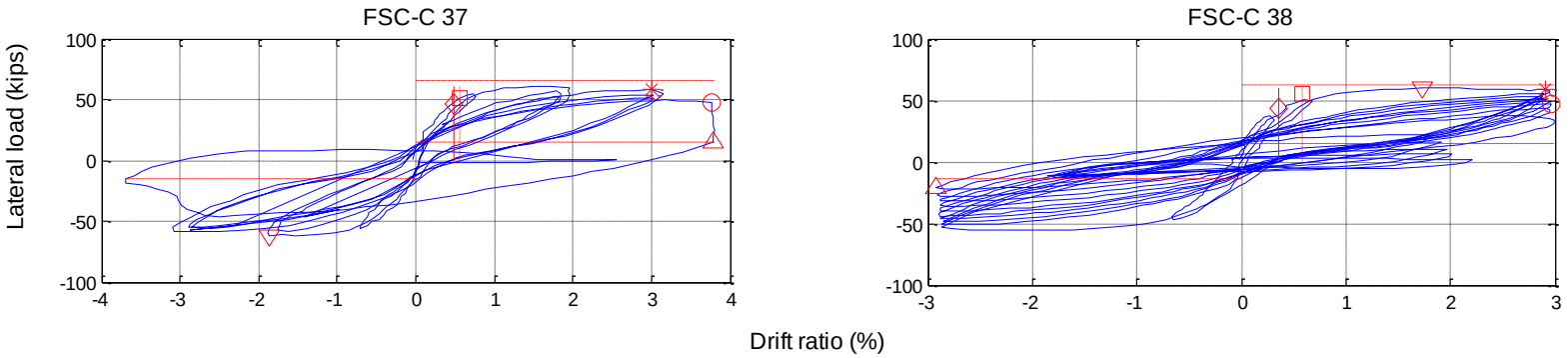
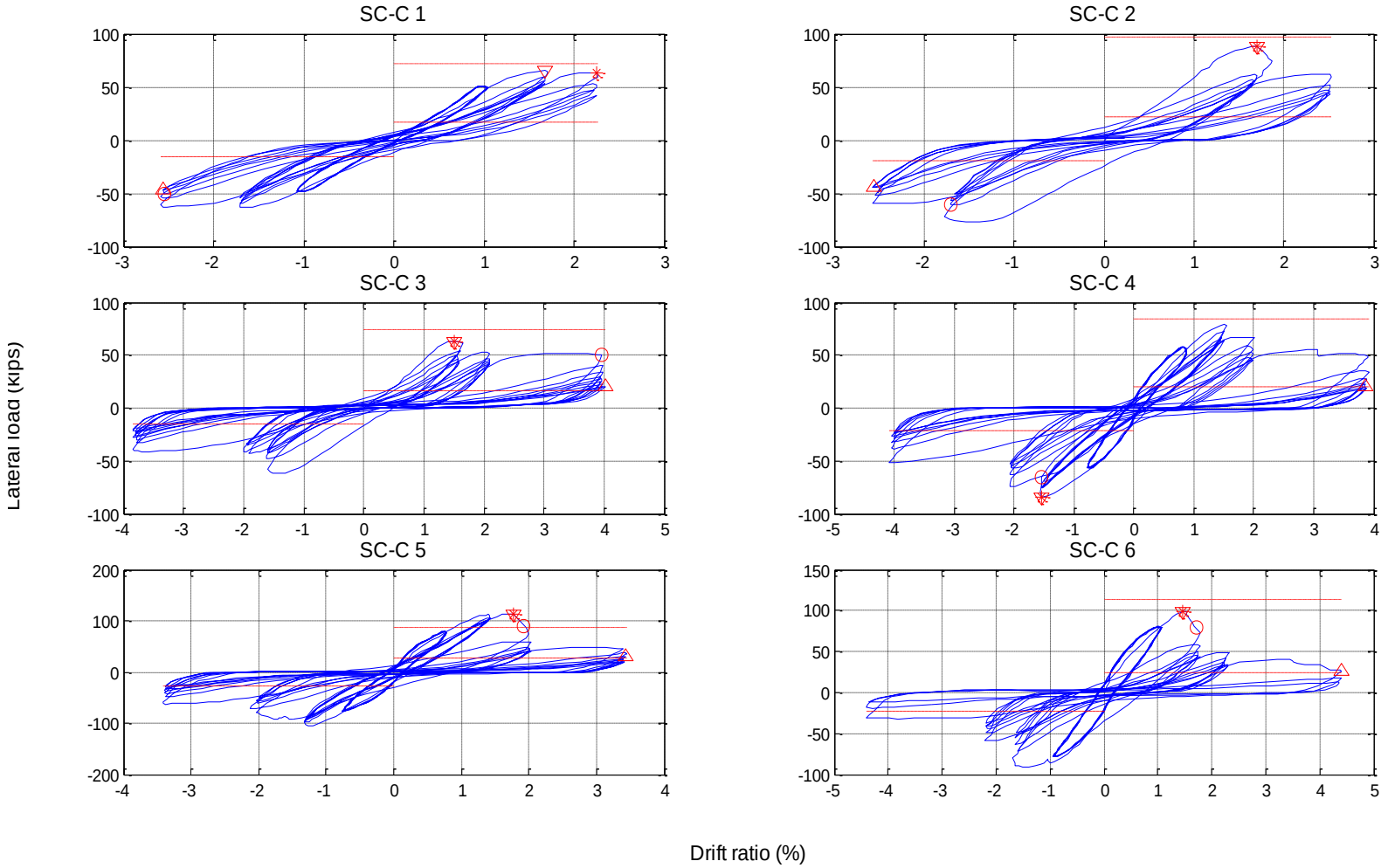
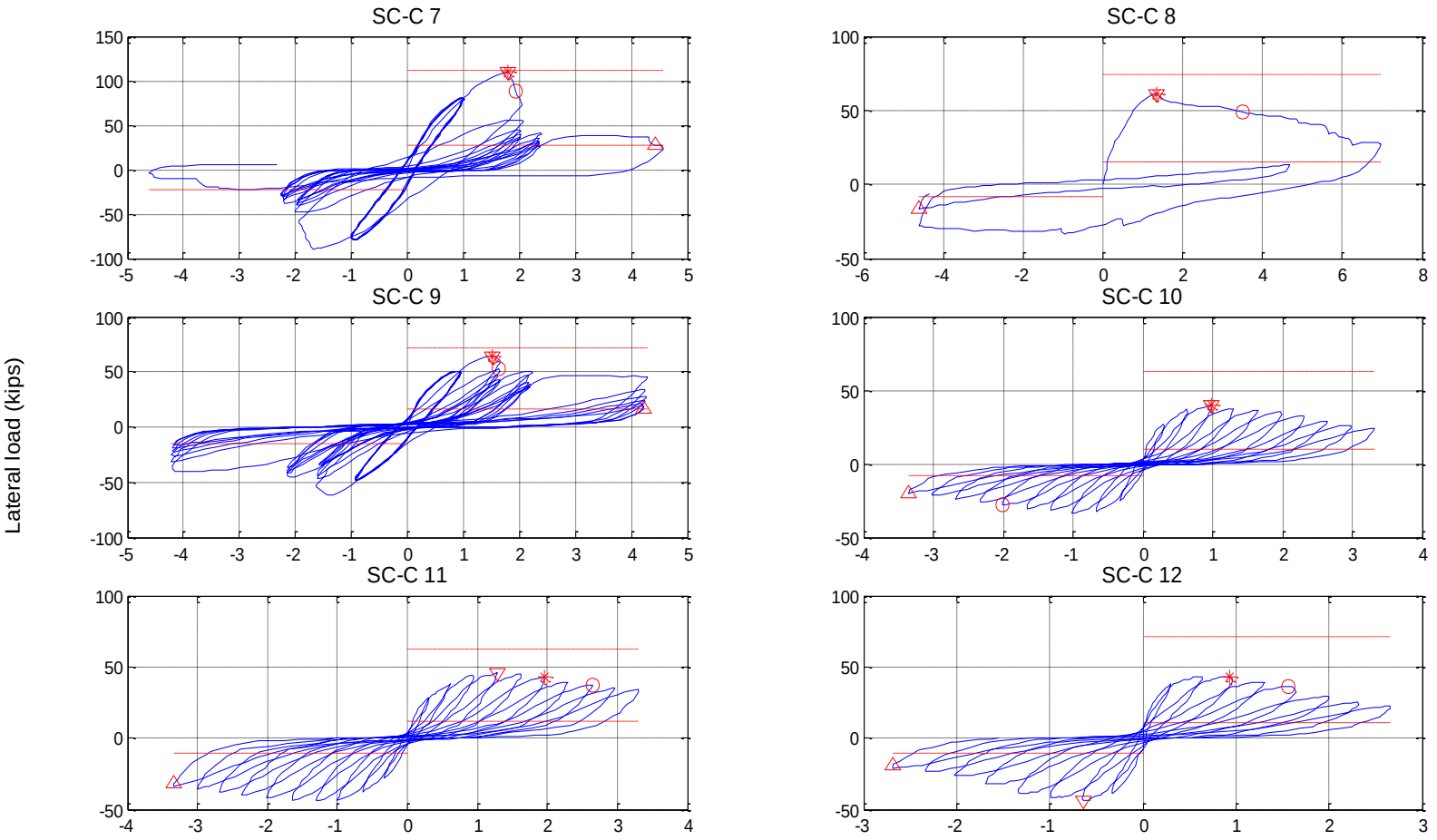
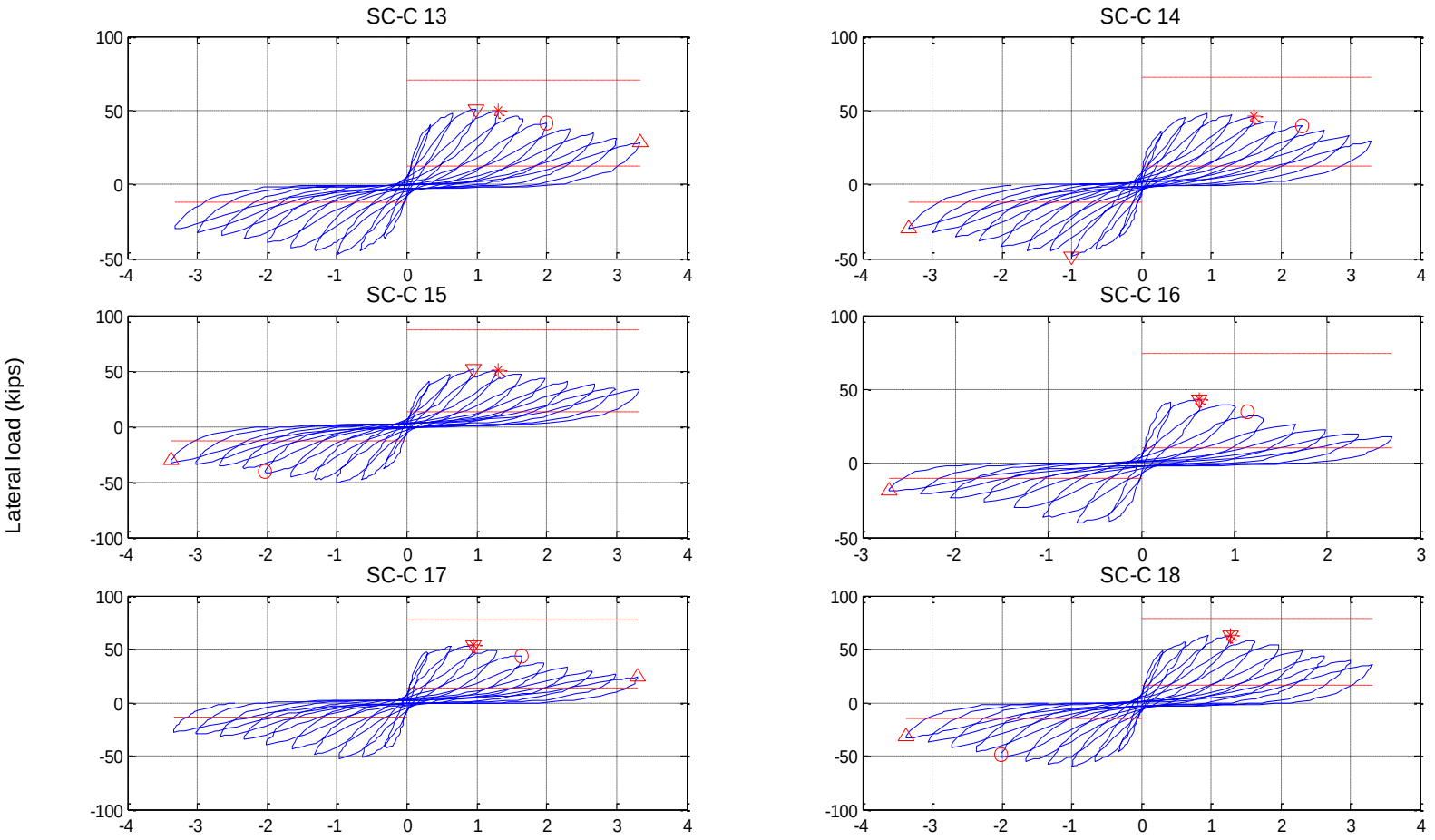
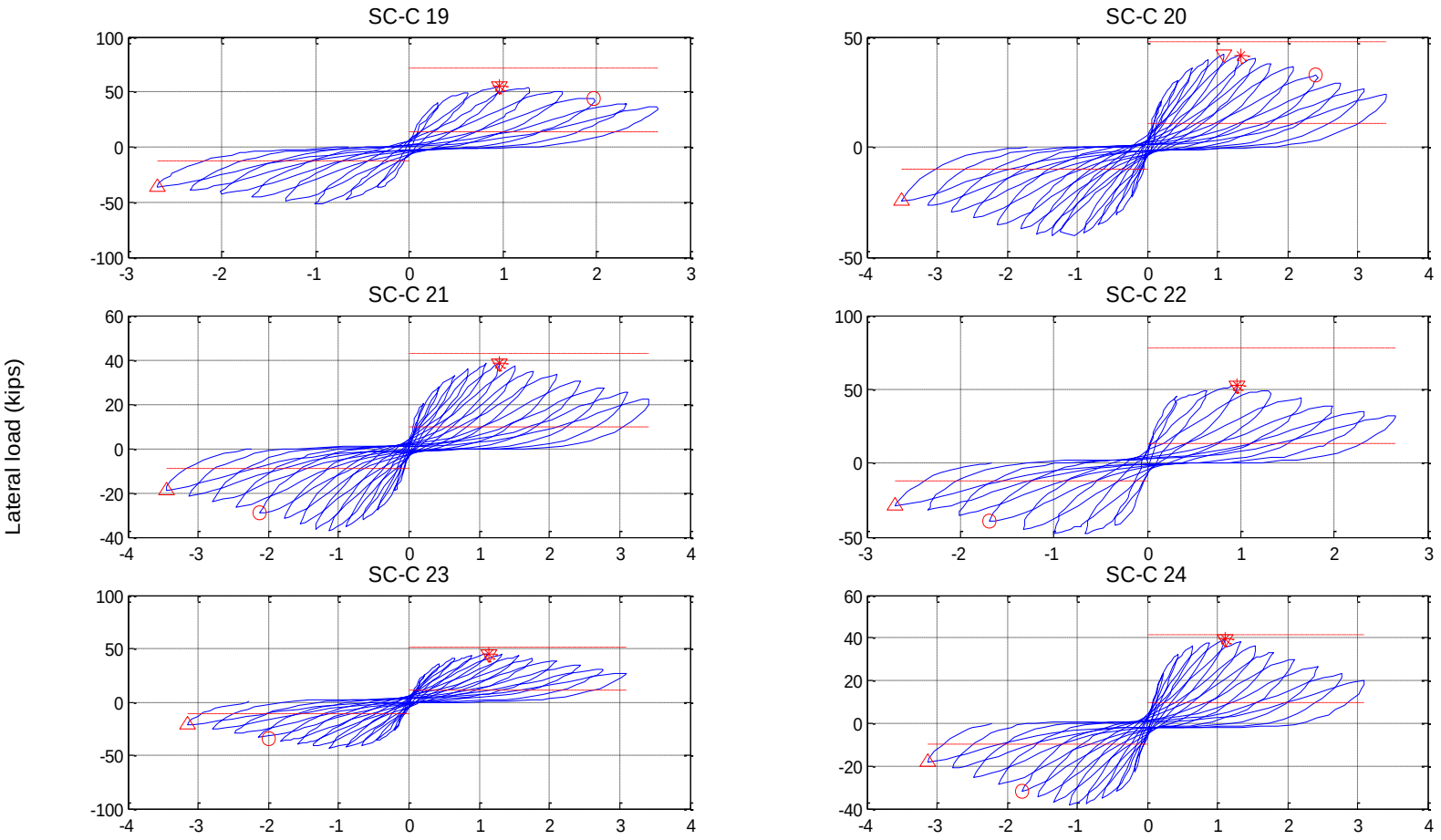

FSC-C 37
FSC-C 38
Lateral load (kips)
Drift ratio (%)
100
50
0
-50
-100
-4
-3
-2
-1
0
1
2
3
4

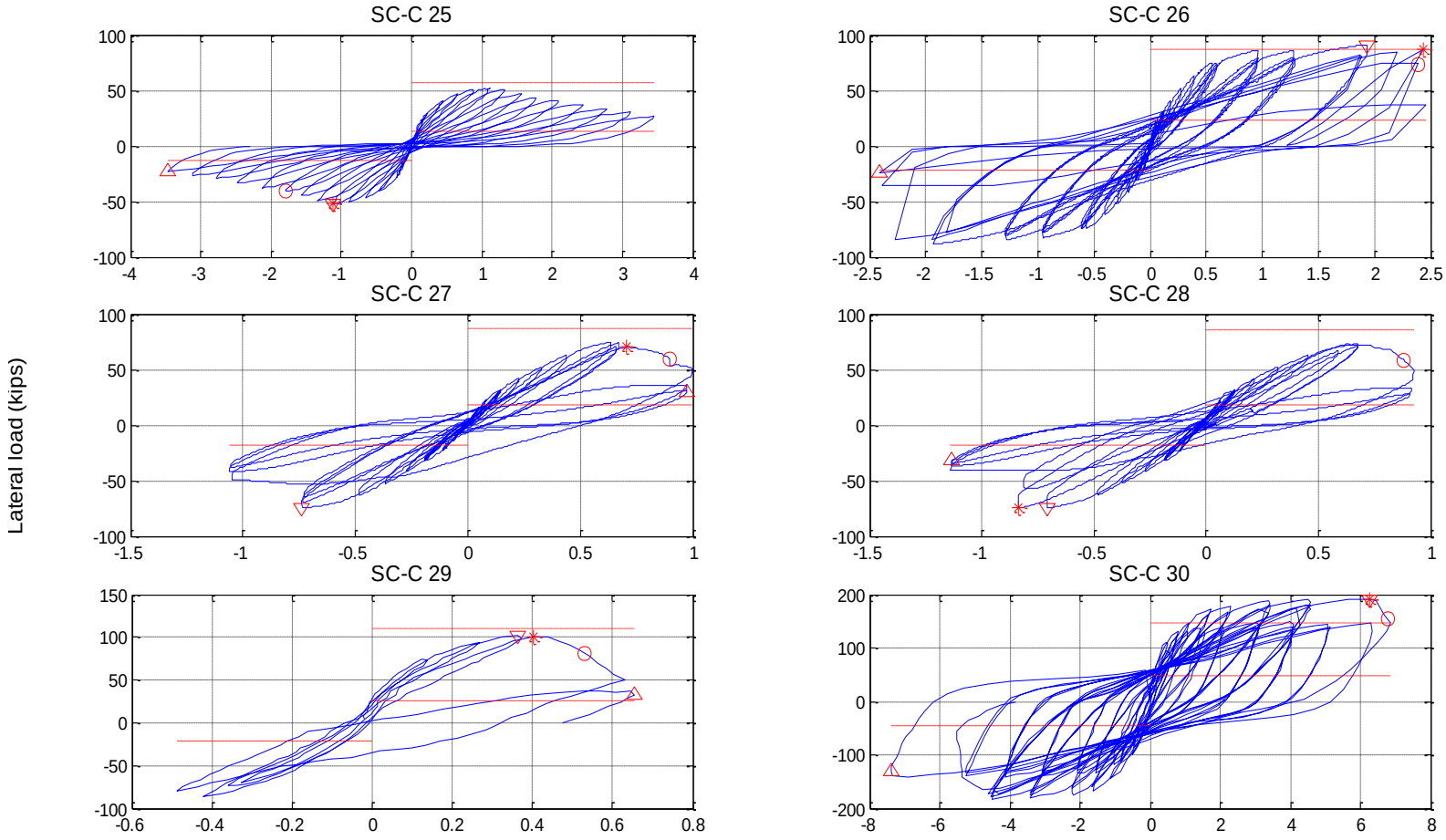
Figure B.6: Force-displacement plots of SC-C columns




SC-C 7
SC-C 8
SC-C 9
SC-C 10
SC-C 11
SC-C 12
Lateral load (kips)
Drift ratio (%)


SC-C 13
SC-C 14
SC-C 15
SC-C 16
SC-C 17
SC-C 18
Lateral load (kips)
Drift ratio (%)


SC-C 19
SC-C 20
SC-C 21
SC-C 22
SC-C 23
SC-C 24
Lateral load (kips)
Drift ratio (%)


SC-C 25
SC-C 26
SC-C 27
SC-C 28
SC-C 29
SC-C 30
Lateral load (kips)
Drift ratio (%)

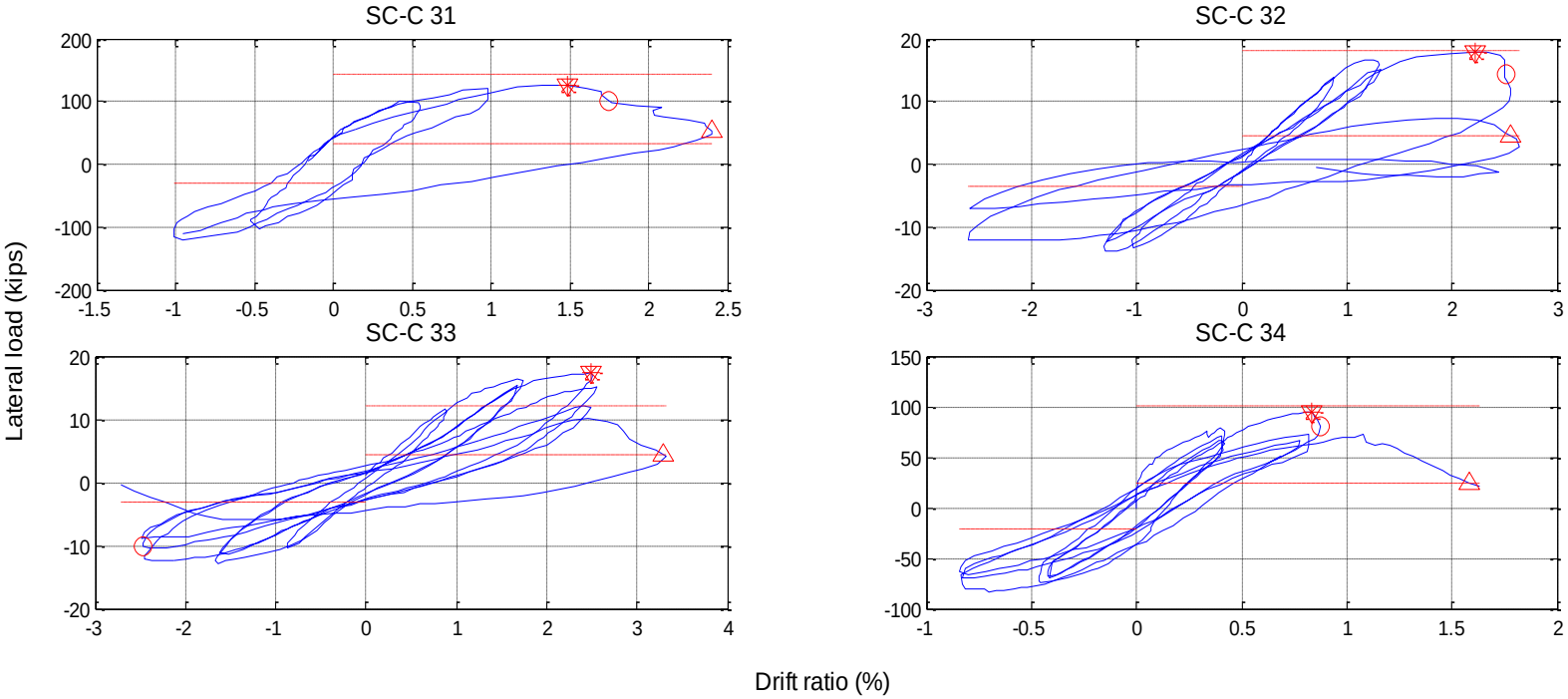

SC-C 31
SC-C 32
SC-C 33
SC-C 34
Lateral load (kips)
Drift ratio (%)

Table B.1: Initial category of rectangular columns and corresponding condition based on ASCE 41.

Column category	Author	Column designation	Condition (as per current ASCE-41 provisions)
FC-R 1	Gill et al.	No.1	i
FC-R 2	Gill et al.	No.2	i
FC-R 3	Gill et al.	No.3	i
FC-R 4	Gill et al.	No.4	i
FC-R 5	Ang et al.	No.3	i
FC-R 6	Ang et al.	No.4	i
FC-R 7	Soesianawati et al.	No. 1	i
FC-R 8	Soesianawati et al.	No. 2	i
FC-R 9	Soesianawati et al.	No. 3	i
FC-R 10	Soesianawati et al.	No. 4	ii
FC-R 11	Zahn	No.7	i
FC-R 12	Zahn	No.8	i
FC-R 13	Watson and Park	No.5	i
FC-R 14	Watson and Park	No.6	i
FC-R 15	Watson and Park	No.7	i
FC-R 16	Watson and Park	No.8	i
FC-R 17	Watson and Park	No.9	i
FC-R 18	Tanaka and Park	No1	i
FC-R 19	Tanaka and Park	No2	i
FC-R 20	Tanaka and Park	No3	i
FC-R 21	Tanaka and Park	No4	i
FC-R 22	Tanaka and Park	No5	i
FC-R 23	Tanaka and Park	No6	i
FC-R 24	Tanaka and Park	No7	i
FC-R 25	Tanaka and Park	No8	i
FC-R 26	Park and Paulay	No9	i
FC-R 27	Arakawa	No.102	i
FC-R 28	Ohno and Nishioka	L1	i
FC-R 29	Ohno and Nishioka	L2	i
FC-R 30	Ohno and Nishioka	L3	i
FC-R 31	Zhou	214-08	i
FC-R 32	Kanda et al.	85STC-1	i
FC-R 33	Kanda et al.	85STC-2	i
FC-R 34	Kanda et al.	85STC-3	i
FC-R 35	Kanda et al.	85PDC-1	i
FC-R 36	Kanda et al.	85PDC-2	i
FC-R 37	Kanda et al.	85PDC-3	i
FC-R 38	Mugurma et al.	AL-1	i

FC-R 39	Mugurma et al.	AH-1	i
FC-R 40	Mugurma et al.	AL-2	i
FC-R 41	Mugurma et al.	AH-2	i
FC-R 42	Mugurma et al.	BL-1	ii
FC-R 43	Mugurma et al.	BH-1	i
FC-R 44	Mugurma et al.	BL-2	i
FC-R 45	Mugurma et al.	BH-2	i
FC-R 46	Sakai et al.	B1	ii
FC-R 47	Sakai et al.	B2	i
FC-R 48	Sakai et al.	B3	ii
FC-R 49	Sakai et al.	B4	i
FC-R 50	Sakai et al.	B5	i
FC-R 51	Sakai et al.	B6	ii
FC-R 52	Sakai et al.	B7	ii
FC-R 53	Atalay and Penzein	No.1S1	i
FC-R 54	Atalay and Penzein	No.2S1	ii
FC-R 55	Atalay and Penzein	No.3S1	i
FC-R 56	Atalay and Penzein	No.4S1	ii
FC-R 57	Atalay and Penzein	No.5S1	i
FC-R 58	Atalay and Penzein	No.6S1	ii
FC-R 59	Atalay and Penzein	No.9	i
FC-R 60	Atalay and Penzein	No.10	ii
FC-R 61	Atalay and Penzein	No.11	i
FC-R 62	Atalay and Penzein	No.12	ii
FC-R 63	Azizinamini et al.	NC 2	i
FC-R 64	Azizinamini et al.	NC 4	i
FC-R 65	Saatcioglu and Ozcebe	U1	ii
FC-R 66	Saatcioglu and Ozcebe	U3	ii
FC-R 67	Saatcioglu and Ozcebe	U4	i
FC-R 68	Saatcioglu and Ozcebe	U6	i
FC-R 69	Saatcioglu and Ozcebe	U7	i
FC-R 70	Galeota et al.	AA1	ii
FC-R 71	Galeota et al.	AA2	ii
FC-R 72	Galeota et al.	AA3	ii
FC-R 73	Galeota et al.	AA4	ii
FC-R 74	Galeota et al.	BA1	i
FC-R 75	Galeota et al.	BA2	i
FC-R 76	Galeota et al.	BA3	i
FC-R 77	Galeota et al.	BA4	i
FC-R 78	Galeota et al.	CA1	i
FC-R 79	Galeota et al.	CA2	i
FC-R 80	Galeota et al.	CA3	i
FC-R 81	Galeota et al.	CA4	i
FC-R 82	Galeota et al.	AB1	ii
FC-R 83	Galeota et al.	AB2	ii
FC-R 84	Galeota et al.	AB3	ii
FC-R 85	Galeota et al.	AB4	ii
FC-R 86	Galeota et al.	BB	ii

FC-R 87	Galeota et al.	BB1	ii
FC-R 88	Galeota et al.	BB4	i
FC-R 89	Galeota et al.	BB4B	i
FC-R 90	Galeota et al.	CB1	i
FC-R 91	Galeota et al.	CB2	i
FC-R 92	Galeota et al.	CB3	i
FC-R 93	Galeota et al.	CB4	i
FC-R 94	Wehbe et al.	A1	ii
FC-R 95	Wehbe et al.	A2	ii
FC-R 96	Wehbe et al.	B1	i
FC-R 97	Wehbe et al.	B2	i
FC-R 98	Xiao and Martirossyan	HC4-8L19-T10-0.1P	i
FC-R 99	Xiao and Martirossyan	HC4-8L19-T10-0.2P	i
FC-R 100	Xiao and Martirossyan	HC4-8L16-T10-0.1P	i
FC-R 101	Xiao and Martirossyan	HC4-8L16-T10-0.2P	i
FC-R 102	Sugano	UC10H	i
FC-R 103	Sugano	UC15H	i
FC-R 104	Sugano	UC20H	i
FC-R 105	Sugano	UC15L	i
FC-R 106	Sugano	UC20L	i
FC-R 107	Nosho et al	No.1	ii
FC-R 108	Bayrak and Sheikh	ES-1HT	i
FC-R 109	Bayrak and Sheikh	AS-2HT	i
FC-R 110	Bayrak and Sheikh	AS-3HT	i
FC-R 111	Bayrak and Sheikh	AS-4HT	i
FC-R 112	Bayrak and Sheikh	AS-5HT	i
FC-R 113	Bayrak and Sheikh	AS-6HT	i
FC-R 114	Bayrak and Sheikh	AS-7HT	i
FC-R 115	Bayrak and Sheikh	ES-8HT	i
FC-R 116	Saatcioglu and Giria	BG-1	ii
FC-R 117	Saatcioglu and Giria	BG-2	i
FC-R 118	Saatcioglu and Giria	BG-3	i
FC-R 119	Saatcioglu and Giria	BG-4	ii
FC-R 120	Saatcioglu and Giria	BG-5	i
FC-R 121	Saatcioglu and Giria	BG-6	i
FC-R 122	Saatcioglu and Giria	BG-7	i
FC-R 123	Saatcioglu and Giria	BG-8	i
FC-R 124	Saatcioglu and Giria	BG-9	i
FC-R 125	Saatcioglu and Giria	BG-10	i
FC-R 126	Matamoros et al.	C10-05N	ii
FC-R 127	Matamoros et al.	C10-05S	ii
FC-R 128	Matamoros et al.	C10-10N	i
FC-R 129	Matamoros et al.	C10-10S	i
FC-R 130	Matamoros et al.	C10-20N	i
FC-R 131	Matamoros et al.	C10-20S	i
FC-R 132	Matamoros et al.	C5-00N	i
FC-R 133	Matamoros et al.	C5-00S	i
FC-R 134	Matamoros et al.	C5-20N	ii

FC-R 135	Matamoros et al.	C5-20S	ii
FC-R 136	Matamoros et al.	C5-40N	i
FC-R 137	Matamoros et al.	C5-40S	i
FC-R 138	Mo and Wang	C1-1	i
FC-R 139	Mo and Wang	C1-2	i
FC-R 140	Mo and Wang	C1-3	i
FC-R 141	Mo and Wang	C2-1	i
FC-R 142	Mo and Wang	C2-2	i
FC-R 143	Mo and Wang	C2-3	i
FC-R 144	Mo and Wang	C3-1	i
FC-R 145	Mo and Wang	C3-2	i
FC-R 146	Mo and Wang	C3-3	i
FC-R 147	Aboutaha and Machado	ORC1	i
FC-R 148	Aboutaha and Machado	ORC2	i
FC-R 149	Aboutaha and Machado	ORC3	i
FC-R 150	Thomsen and Wallace	A1	i
FC-R 151	Thomsen and Wallace	A3	i
FC-R 152	Thomsen and Wallace	B1	i
FC-R 153	Thomsen and Wallace	B2	i
FC-R 154	Thomsen and Wallace	B3	i
FC-R 155	Thomsen and Wallace	C1	i
FC-R 156	Thomsen and Wallace	C2	i
FC-R 157	Thomsen and Wallace	C3	i
FC-R 158	Thomsen and Wallace	D1	i
FC-R 159	Thomsen and Wallace	D2	i
FC-R 160	Thomsen and Wallace	D3	i
FC-R 161	Paultre & Legeron	1006015	i
FC-R 162	Paultre & Legeron	1006025	i
FC-R 163	Paultre & Legeron	1006040	i
FC-R 164	Paultre & Legeron	10013015	i
FC-R 165	Paultre & Legeron	10013025	i
FC-R 166	Paultre & Legeron	10013040	i
FC-R 167	Paultre et al.	806040	i
FC-R 168	Paultre et al.	1206040	i
FC-R 169	Paultre et al.	1005540	i
FC-R 170	Paultre et al.	1008040	i
FC-R 171	Paultre et al.	1005552	i
FC-R 172	Paultre et al.	1006052	i
FC-R 173	Pujol	10-2-3N	ii
FC-R 174	Pujol	10-2-3S	ii
FC-R 175	Pujol	10-3-1.5N	i
FC-R 176	Pujol	10-3-1.5S	i
FC-R 177	Pujol	10-3-3N	ii
FC-R 178	Pujol	10-3-3S	ii
FC-R 179	Pujol	10-3-2.25N	ii
FC-R 180	Pujol	10-3-2.25S	ii
FC-R 181	Pujol	20-3-3N	ii
FC-R 182	Pujol	20-3-3S	ii

FC-R 183	Pujol	10-2-2.25N	ii
FC-R 184	Pujol	10-2-2.25S	ii
FC-R 185	Pujol	10-1-2.25N	ii
FC-R 186	Pujol	10-1-2.25S	ii
FC-R 187	Bechtoula, Kono, Arai and Watanabe	D1N30	ii
FC-R 188	Bechtoula, Kono, Arai and Watanabe	D1N60	1
FC-R 189	Bechtoula, Kono, Arai and Watanabe	L1D60	1
FC-R 190	Bechtoula, Kono, Arai and Watanabe	L1N60	1
FC-R 191	Bechtoula, Kono, Arai and Watanabe	L1N6B	1
FC-R 192	Takemura and Kawashima	Test 1	ii
FC-R 193	Takemura and Kawashima	Test 2	ii
FC-R 194	Takemura and Kawashima	Test 3	ii
FC-R 195	Takemura and Kawashima	Test 4	ii
FC-R 196	Takemura and Kawashima	Test 5	ii
FC-R 197	Takemura and Kawashima	Test 6	ii
FSC-R 1	Nagasaka	HPRC19-32	i
FSC-R 2	Ohue	2D16RS	ii
FSC-R 3	Ohue	4D13RS	ii
FSC-R 4	Zhou	1007	ii
FSC-R 5	Zhou	204-08	i
FSC-R 6	Zhou	223-09	i
FSC-R 7	Zhou	302-07	i
FSC-R 8	Zhou	312-07	i
FSC-R 9	Ono	CA025C	i
FSC-R 10	Ono	CA060C	i
FSC-R 11	Amitsu	CB060C	i
FSC-R 12	Wight	WI_40_033aE	iii
FSC-R 13	Wight	WI_40_033aW	iii
FSC-R 14	Wight	WI_40_048E	ii
FSC-R 15	Wight	WI_40_048W	ii
FSC-R 16	Wight	WI_40_033_E	iii
FSC-R 17	Wight	WI_40_033_W	iii
FSC-R 18	Wight	WI_25_033_E	ii
FSC-R 19	Wight	WI_25_033_W	ii
FSC-R 20	Wight	WI_0_048W	ii
FSC-R 21	Wight	WI_40_067_E	ii
FSC-R 22	Wight	WI_40_067_W	ii
FSC-R 23	Wight	WI_40_147_E	i
FSC-R 24	Wight	WI_40_147_W	i
FSC-R 25	Wight	WI_40_092_E	i
FSC-R 26	Wight	WI_40_092_W	i
FSC-R 27	Lynn	2CLH18	ii
FSC-R 28	Lynn	2CMH18	ii

FSC-R 29	Lynn	2SLH18	ii
FSC-R 30	Lynn	3SMD12	ii
FSC-R 31	Xiao	HC4-8L16-T6-0.1P	ii
FSC-R 32	Xiao	HC4-8L16-T6-0.2P	ii
FSC-R 33	Sezen	Specimen_1	ii
FSC-R 34	Sezen	Specimen_2	ii
FSC-R 35	Sezen	Specimen_4	ii
FSC-R 36	Iwasaki	I_03	ii
FSC-R 37	Iwasaki	I_04	ii
FSC-R 38	Iwasaki	I_10	ii
FSC-R 39	Iwasaki	I_14	ii
FSC-R 40	Iwasaki	I_16	ii
FSC-R 41	Iwasaki	I_17	ii
FSC-R 42	Iwasaki	I_20	ii
FSC-R 43	Iwasaki	I_25	i
FSC-R 44	Ikeda	IK_43	ii
FSC-R 45	Ikeda	IK_44	ii
FSC-R 46	Ikeda	IK_45	ii
FSC-R 47	Ikeda	IK_46	ii
FSC-R 48	Ikeda	IK_62	ii
FSC-R 49	Ikeda	IK_63	ii
FSC-R 50	Ikeda	IK_64	ii
FSC-R 51	Umemura & Endo	UM_205	ii
FSC-R 52	Umemura & Endo	UM_207	ii
FSC-R 53	Umemura & Endo	UM_214	ii
FSC-R 54	Umemura & Endo	UM_220	ii
FSC-R 55	Umemura & Endo	UM_231	ii
FSC-R 56	Umemura & Endo	UM_232	ii
FSC-R 57	Umemura & Endo	UM_233	ii
FSC-R 58	Umemura & Endo	UM_234	ii
FSC-R 59	Kokusho	KO_372	ii
FSC-R 60	Kokusho	KO_373	ii
FSC-R 61	Kokusho & Fukuhara	KO_452	ii
FSC-R 62	Kokusho & Fukuhara	KO_454	ii
FSC-R 63	Yalcin	BR-S1	iii
FSC-R 64	Elwood	Specimen1	ii
FSC-R 65	Elwood	Specimen2	ii
FSC-R 66	Verma	UnitR1A	iii
FSC-R 67	Saatcioglu	U2	ii
FSC-R 68	Esaki	H-2-1_3	ii
FSC-R 69	Esaki	H-2-1_5	ii
FSC-R 70	Esaki	HT-2-1_3	ii
FSC-R 71	Esaki	HT-2-1_5	ii
FSC-R 72	Lynn	3CMH18	iii
FSC-R 73	Lynn	3CMD12	ii
FSC-R 74	Lynn	3SLH18	iii
FSC-R 75	Yoshimura	Unit_6	ii
FSC-R 76	Yoshimura	Unit_7	iii

FSC-R 77	Yarandi	RRC	iii
FSC-R 78	Yarandi	SRC	ii
FSC-R 79	Pandey	A4	ii
FSC-R 80	Pandey	C1	iii
FSC-R 81	Yoshimura	FS0	ii
FSC-R 82	Yoshimura	FS1	ii
SC-R 1	Nagasaka	HPRC_1063	i
SC-R 2	Imai	UNIT_1	iii
SC-R 3	Zhou	UNIT_10408	i
SC-R 4	Zhou	UNIT_11408	i
SC-R 5	Zhou	UNIT_12408	i
SC-R 6	Arakawa	OA2	iii
SC-R 7	Arakawa	OA5	iii
SC-R 8	Umehara	CUS	iii
SC-R 9	Umehara	CUW	ii
SC-R 10	Bett	UNIT_1_1	iii
SC-R 11	Aboutaha	SC3	iii
SC-R 12	Aboutaha	SC9	iii
SC-R 13	Iwasaki	I18	ii
SC-R 14	Iwasaki	I21	ii
SC-R 15	Verma	UnitR3A	iii
SC-R 16	Verma	UnitR5A	iii
SC-R 17	Pandey	Specimen_B1	iii
SC-R 18	Yoshimura	Specimen_CE	iii
SC-R 19	Yoshimura	Specimen_BE	iii
SC-R 20	Yoshimura	Specimen_LE	iii
SC-R 21	Yoshimura	No.1	iii
SC-R 22	Yoshimura	No.3	iii
SC-R 23	Yoshimura	No.4	iii
SC-R 24	Ousalem	C1	ii
SC-R 25	Ousalem	C4	ii
SC-R 26	Ousalem	C8	ii
SC-R 27	Ousalem	C12	ii
SC-R 28	Ousalem	D1	ii
SC-R 29	Ousalem	D11	iii
SC-R 30	Ousalem	D12	iii
SC-R 31	Ousalem	D13	ii
SC-R 32	Ousalem	D14	ii
SC-R 33	Ousalem	D16	ii
SC-R 34	Nakamura et al.	N-18M	iii
SC-R 35	Nakamura et al.	N-27C	iii
SC-R 36	Nakamura et al.	N-27M	iii
SC-R 37	Yoshimura	S-1	iii
SC-R 38	Wight	WI_0_033E	ii
SC-R 39	Lynn	3CLH18	iii
SC-R 40	Pandey	A1	iii

Table B.2: Initial category of circular columns and corresponding condition based on ASCE 41.

Column category	Author	Column designation	Condition (as per current ASCE-41 provisions)
FC-C 1	Davey	No. 1	ii
FC-C 2	Davey	No. 2	ii
FC-C 3	Davey	No.3	ii
FC-C 4	Munro	No.1	i
FC-C 5	Ng	No. 2	i
FC-C 6	Ng	No.3	i
FC-C 7	Ang	No.1	ii
FC-C 8	Ang	No.2	i
FC-C 9	Potangaroa	No.1	ii
FC-C 10	Potangaroa	No.4	ii
FC-C 11	Potangaroa	No.5A	i
FC-C 12	Potangaroa	No.5B	i
FC-C 13	Ang et al.	No.9	ii
FC-C 14	Zahn et al.	No.5	i
FC-C 15	Zahn et al.	No.6	i
FC-C 16	Watson and Park	No.10	i
FC-C 17	Watson and Park	No.11	i
FC-C 18	Wong et al.	No.1	ii
FC-C 19	Wong et al.	No.3	ii
FC-C 20	Petrovski	M1E1	i
FC-C 21	Petrovski	M1E2	i
FC-C 22	Lim	Con1	i
FC-C 23	Lim	Con2	i
FC-C 24	Lim	Con3	i
FC-C 25	Cheok et al.	NIST, Full scale Flexure	i
FC-C 26	Cheok et al.	NIST Ful sclae shear	i
FC-C 27	Stone	NIST Model N1	i
FC-C 28	Stone	NIST Model N2	i
FC-C 29	Stone	NIST Model N3	i
FC-C 30	Stone	NIST Model N4	i
FC-C 31	Stone	NIST Model N5	i
FC-C 32	Stone	NIST Model N6	i
FC-C 33	Kenchiku Siryo	BRI No.2	i
FC-C 34	Kenchiku Siryo	BRI No.3 ws22bs	ii
FC-C 35	Kenchiku Siryo	BRI No.3 ws27bs	i
FC-C 36	Arakawa	No.16	ii
FC-C 37	Arakawa	No.20	ii
FC-C 38	Arakawa	No.21	iii
FC-C 39	Arakawa	No.26	iii

FC-C 40	Kunnath	A2	i
FC-C 41	Kunnath	A3	i
FC-C 42	Kunnath	A4	i
FC-C 43	Kunnath	A5	i
FC-C 44	Kunnath	A6	i
FC-C 45	Kunnath	A7	i
FC-C 46	Kunnath	A8	i
FC-C 47	Kunnath	A9	i
FC-C 48	Kunnath	A10	i
FC-C 49	Kunnath	A11	i
FC-C 50	Kunnath	A12	i
FC-C 51	Hose et al.	SRPH1	i
FC-C 52	Vu et al.	NH1	ii
FC-C 53	Vu et al.	NH3	ii
FC-C 54	Vu et al.	NH6	i
FC-C 55	Kowalsky	FL1	i
FC-C 56	Kowalsky	FL2	i
FC-C 57	Kowalsky	FL3	ii
FC-C 58	Lehman et al	415	i
FC-C 59	Lehman et al	815	i
FC-C 60	Lehman et al	1015	i
FC-C 61	Lehman et al	407	i
FC-C 62	Lehman et al	430	i
FC-C 63	Calderone et al.	328	i
FC-C 64	Calderone et al.	828	i
FC-C 65	Calderone et al.	1028	i
FC-C 66	Sritharan et al. 1995	IC1	ii
FC-C 67	Sritharan et al. 1995	B105IC2	ii
FC-C 68	Sritharan et al. 1995	IC3	i
FC-C 69	Saatcioglu and Baingo	RC1	i
FC-C 70	Saatcioglu and Baingo	RC2	i
FC-C 71	Saatcioglu and Baingo	RC3	i
FC-C 72	Saatcioglu and Baingo	RC4	i
FC-C 73	Saatcioglu and Baingo	RC6	i
FC-C 74	Saatcioglu and Baingo	RC7	i
FC-C 75	Saatcioglu and Baingo	RC8	i
FC-C 76	Saatcioglu and Baingo	RC9	i
FC-C 77	Nelson and Price	Col 1	ii
FC-C 78	Nelson and Price	Col 2	ii
FC-C 79	Nelson and Price	Col 3	ii
FC-C 80	Nelson and Price	Col 4	ii
FC-C 81	Henry	415p	i
FC-C 82	Henry	415s	ii
FC-C 83	Chai	Test3	ii
FC-C 84	Soderstrom	C1	i
FC-C 85	Soderstrom	C2	i
FC-C 86	Soderstrom	C3	i
FC-C 87	Soderstrom	C4	i

FC-C 88	Graff	C5	i
FC-C 89	Graff	C6	i
FC-C 90	Graff	C7	i
FC-C 91	Graff	C8	i
FC-C 92	Kowalsky and Moyer	1	i
FC-C 93	Kowalsky and Moyer	2	i
FC-C 94	Kowalsky and Moyer	3	i
FC-C 95	Kowalsky and Moyer	4	i
FC-C 96	Coffman	1	ii
FC-C 97	Hamilton	UC1	i
FC-C 98	Hamilton	UC2	i
FC-C 99	Hamilton	UC3	i
FSC-C 1	Potangaroa	Unit No.3 (Potangaroa)	i
FSC-C 2	Ang_Beng_Ghee	Unit No.1	iii
FSC-C 3	Ang_Beng_Ghee	Unit No.2	iii
FSC-C 4	Ang_Beng_Ghee	Unit No.3	iii
FSC-C 5	Ang_Beng_Ghee	Unit No.5	iii
FSC-C 6	Ang_Beng_Ghee	Unit No.8	ii
FSC-C 7	Ang_Beng_Ghee	Unit No.10	ii
FSC-C 8	Ang_Beng_Ghee	Unit No.11	iii
FSC-C 9	Ang_Beng_Ghee	Unit No.12	iii
FSC-C 10	Ang_Beng_Ghee	Unit No.13	iii
FSC-C 11	Ang_Beng_Ghee	Unit No.14	iii
FSC-C 12	Ang_Beng_Ghee	Unit No.15	ii
FSC-C 13	Ang_Beng_Ghee	Unit No.17	iii
FSC-C 14	Ang_Beng_Ghee	Unit No.23	iii
FSC-C 15	Ang_Beng_Ghee	Unit No.24	iii
FSC-C 16	Wong	Unit No.2 (Wong)	iii
FSC-C 17	Petrovski	M2E1	i
FSC-C 18	Petrovski	M2E2	i
FSC-C 19	Kenchiku Kenkyu Siryo	ws21bs	i
FSC-C 20	Kenchiku Kenkyu Siryo	ws25bs	i
FSC-C 21	Kenchiku Kenkyu Siryo	ws26bs	ii
FSC-C 22	Arakawa	Unit No.10	iii
FSC-C 23	Arakawa	Unit No.15	iii
FSC-C 24	Arakawa	Unit No.23	ii
FSC-C 25	Priestley	NR 1	ii
FSC-C 26	Priestley	NR2	iii
FSC-C 27	Vu	NH2	ii
FSC-C 28	Vu	NH4	ii
FSC-C 29	Vu	NH5	ii
FSC-C 30	Hamilton	UC13	iii
FSC-C 31	Hamilton	UC14	iii
FSC-C 32	Hamilton	UC15	ii
FSC-C 33	Chai	CCS1	iii
FSC-C 34	Iwasaki	I 30	iii

FSC-C 35	Ranf	Specimen S1	ii
FSC-C 36	Ranf	Specimen S3	ii
FSC-C 37	Ranf	Specimen C2	ii
FSC-C 38	Ranf	Specimen C3R	ii
SC-C 1	Ang_Beng_Ghee	UNIT 4	iii
SC-C 2	Ang_Beng_Ghee	UNIT 6	iii
SC-C 3	Ang_Beng_Ghee	UNIT 7	iii
SC-C 4	Ang_Beng_Ghee	UNIT 16	iii
SC-C 5	Ang_Beng_Ghee	UNIT 18	iii
SC-C 6	Ang_Beng_Ghee	UNIT 19	iii
SC-C 7	Ang_Beng_Ghee	UNIT 20	iii
SC-C 8	Ang_Beng_Ghee	UNIT 21	iii
SC-C 9	Ang_Beng_Ghee	UNIT 22	iii
SC-C 10	Arakawa	UNIT 1	iii
SC-C 11	Arakawa	UNIT 2	iii
SC-C 12	Arakawa	UNIT 4	iii
SC-C 13	Arakawa	UNIT 6	iii
SC-C 14	Arakawa	UNIT 8	iii
SC-C 15	Arakawa	UNIT 9	iii
SC-C 16	Arakawa	UNIT 12	iii
SC-C 17	Arakawa	UNIT 13	iii
SC-C 18	Arakawa	UNIT 14	iii
SC-C 19	Arakawa	UNIT 17	iii
SC-C 20	Arakawa	UNIT 19	iii
SC-C 21	Arakawa	UNIT 22	iii
SC-C 22	Arakawa	UNIT 24	iii
SC-C 23	Arakawa	UNIT 25	iii
SC-C 24	Arakawa	UNIT 27	iii
SC-C 25	Arakawa	UNIT 28	iii
SC-C 26	McDaniel	UNIT S-1	iii
SC-C 27	McDaniel	UNIT S1-2	iii
SC-C 28	McDaniel	UNIT S2	iii
SC-C 29	Hussein	Unit CS-A1	iii
SC-C 30	Xiao	Unit CS-A	iii
SC-C 31	Yalcin	Specimen BR-C1	iii
SC-C 32	Omar	Specimen S1	iii
SC-C 33	Omar	Specimen S3	ii
SC-C 34	Yarandi	Specimen CR-C	iii

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